Project Deliverable Report Instructions

This document is a template for the project deliverable submissions. Your group will edit this document all semester and submit it each time you have an updated section (new deliverable is done). Please keep track changes ON so that the TA can see what has been changed every time it gets submitted.

Template conventions:

- Remove all red text, it is only there to guide you
- Remove this page (instructions)
- Replace all instances of <xxx> with the appropriate information for your group, for example you could replace <GROUP NUMBER> by ‘B1.3’

GNG2101

Design Project Progress Update

Talk and Music Box
B5.3

Submitted by:

Tazim Khan, 300282353

Rynak Iqbal, 300315593

Stephane Niyonizigiye, 300242927

<Anthony Traboulsi, 300309949>

<Date>

University of Ottawa

Table of Contents

List of Figures

Insert your list of figures here (right-click to update this field).

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

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

1 Introduction

Explain the basic context for your work and any assumptions that you have made for your work. Give an overview of the structure of your document (i.e. explain how it is organized) and summarize the purpose of the document and the scope of activities.

2 Business Model Canvas and DFX

2.1 Business model and sustainability report

1. Identify and describe your value proposition that would be well suited to commercializing your team's product. Discuss the reasons for your choice

The Music Talk Box offers entertainment and communication opportunities for those with verbal, visual, and physical limitations. We believe these are our value propositions as they are the main points our Talk Box is dedicated to based on our client description. Our product will be portable and easy to carry, whether it be by hand or on a wheelchair tray. It will also have an earbud for the user so they can navigate through the Talk Box UI by ear. It will also come with a joystick for UI navigation. This is to ensure anyone, despite physical limitations, can easily use the talk box with minimal movement required.

2. Fill in a triple bottom line business model canvas by answering the how, what, who and how much of your chosen business model

Key Partners	**Key Activities**	**Value Proposition**	**Customer Relationships**	**Customer Segments**
Our key partners for this project are the client Emilie, Dr Rubina Lahkani, CEED members, our TA Anjali Balakrishnan, and our PM Feryza Damji. Our client will help us as they are key to this entire project, and all of the components of the final project must meet their needs. Our professor, TA and PM, and the CEED members are all partners who have the	For our business to function we need constant communication, both with the client, and with each other as project team mates. This way we can ensure a clear problem and solution for our project, which will guide us to a functional business. By having a functional business, our product will be successful.	We are addressing the problems that those with verbal, visual, and physical limitations face when interacting with those around them. We will also give those with these limitations the same opportunities to have fun as everyone else with the potential addition of	Long-term and co-creation are our main customer relationship types. We plan to create a deep and long-term connection with our customers to ensure that we are aware that our product is continuing to satisfy their needs, and can respond whenever changes are required. We will also be professional and treat our customers with mutual respect.	We aim to create this product for those who have speech limitations. Hence being a talk box, it will give those who have speech limitations the same opportunities to communicate with those around them as everyone else. The way the talk box will be engineered will also be geared toward those with visual and physical limitations.

<table>
<tr>
<td>previous experience and knowledge to help guide us to a successful final product.</td>
<td>Key Resources

Employees:
- Mechanical, electrical, software engineers
- Researchers
- Sales and marketing team

Product Resources:
- Raspberry pi board
- Bread board
- Joystick
- Speaker, earbud
- LCD screen
- Power source (batteries?)
- 3D-printer

Financial aid</td>
<td>audio books, music, games, etc.

Customers will love us because we address issues that most mainstream devices on the market don’t focus on. We are creating a piece of technology that is geared solely for those with everyday limitations and is something that will be 100% for their benefit.</td>
<td>Channels

Delivery will be done in person by a designated representative.</td>
<td></td>
</tr>
<tr>
<td colspan="3">Cost Structure

Talk box materials: Material, fixed, direct
Employee salaries: Labour, variable, indirect
Marketing: Expenses, variable, direct
Business building (rent, electricity): Expenses, fixed, indirect

All costs for talk box materials must add up to below our fixed budget of $100.</td>
<td colspan="2">Revenue Streams

Our main source of income will be from customers purchasing our product. Therefore, our main revenue stream will be transaction based.

Our pricing will be set based on the production cost and average monthly expenses for our business.</td>
</tr>
<tr>
<td colspan="3">Social and Environmental Cost</td>
<td colspan="2">Social and Environmental Benefits</td>
</tr>
</table>

The manufacturing of the hardware we will use will involve the extraction of raw materials to be processed. This, along with its disposal, will contribute to greenhouse gas emissions, resource depletion, waste generation, and pollution.	Our product will allow disabled persons more ways to communicate. Beyond making their daily activities easier, it will reduce the prejudices of the people they interact with, once they realize that people with disabilities are capable of the same actions as them. Doubly, our product will reduce the need for unnecessary travel and face-to-face interactions to effectively communicate, thereby reducing carbon emissions associated with transportation.

3. Describe the core assumptions that you have made in developing your business model canvas and comment on its feasibility. Important: These core assumptions should be based on the business model you have chosen and not on your prototype (e.g. what type of clients do you assume your product will attract?).

Core assumptions we have made in developing our business model canvas are that the majority of our customers will be visually and/or physically impaired and that business will be conducted by representatives who are perfectly able. Operating on the falsehood of this would require us to firstly, put more emphasis on marketing to compensate for the loss of inherent demand and secondly, accommodate for accessibility in many more areas such as the discussion and delivery of our product. This is not feasible due to our current lack of resources and time constraints.

4. Provide a sustainability report that reflects on at least two of your product's major social, environmental, and economic impacts, both positive and negative. Perform a simple analysis of these impacts and use this analysis to help you fill in the triple bottom line of your business model canvas.

Environmental Impact:

<u>Negative Impact: Resource Depletion and Waste Generation</u>

The manufacturing process of the Talk and Music Box involves the extraction and processing of raw materials for its hardware components, such as the Raspberry Pi board, breadboard, LCD screen, and 3D-printed parts. This process contributes to resource depletion and generates waste.

<u>Positive Impact: Reduced Carbon Emissions and Pollution</u>

Our product promotes inclusivity and accessibility, allowing individuals with speech, visual, and physical limitations to communicate effectively. By doing so, it reduces the need for unnecessary travel and face-to-face interactions, thereby potentially reducing carbon emissions associated with transportation. Additionally, improved communication may lead to reduced misunderstandings and conflicts, indirectly contributing to a reduction in social pollution.

Social Impact:

Positive Impact: Enhanced Inclusivity and Opportunities

Our product is designed to address the communication challenges faced by individuals with verbal, visual, and physical limitations. By providing a dedicated and user-friendly communication tool, it enhances inclusivity and empowers these individuals to participate more actively in social interactions, education, and employment opportunities.

Positive Impact: Reduced Stigma and Prejudice

Our product helps bridge communication gaps between individuals with limitations and those without. As a result, it has the potential to reduce prejudices and misconceptions about the capabilities of people with disabilities. By showcasing that individuals with disabilities can participate in everyday activities like communication and entertainment, the product can contribute to changing societal attitudes.

Economic Impact:

Positive Impact: Revenue Generation

The primary revenue stream for our business is through the sale of the product. By providing a solution that caters to the specific needs of individuals with limitations, we have the potential to generate substantial revenue while simultaneously addressing an underserved market.

Negative Impact: Manufacturing Costs

The manufacturing and production costs associated with the box, including materials and labor, can be substantial. Ensuring that the product remains affordable while maintaining quality is a challenge that may impact our profitability.

In summary, our model has both positive and negative impacts across social, environmental, and economic dimensions:

Positive Impacts: Enhanced inclusivity, reduced stigma, reduced carbon emissions, and improved communication opportunities.

Negative Impacts: Resource depletion and waste generation during manufacturing, manufacturing costs that could affect profitability.

To improve sustainability, we can consider measures to reduce the environmental footprint of our manufacturing process, such as exploring more sustainable materials and production methods. Additionally, efforts to continually improve our product's accessibility and affordability can enhance its positive social and economic impacts.

2.2 Design for X

5 Most important factors:

1. **Accessible user interface**: This is the most important factor since our client has limited physical movements. The interface should be well organized and the buttons should be large to minimize the risk of accidental input by the client. Also, the interface should be easy to learn and operate.
2. **Joystick and earbud design**: the joystick will be the primary navigation tool for the client on the interface. After speaking to the client's mother, we found out that the best way for her son to physically interact with the talk box would be through his left hand. Therefore the joystick should be designed for comfortable use somewhere on the left side of his wheelchair. For the earbud, since the client has very strong hearing capabilities it will be important to design a comfortable good quality earbud. This will be the primary output feature of the talk box.
3. **Customization and adaptability:** This is an important factor when it comes to the user's control of the talk box. The device will have options that allow the user to decrease/increase volume and it will allow the client to adapt based on his preferences.

4. **Color Red:** This is an important factor because it is essential for the client's visual interaction with the interface. The client's mother mentioned that red is the preferred color as the contrast is crucial for her son's visual limitations.
5. **Durability and reliability:** Evidently, durability and reliability are important factors when designing a product. Given the fact theat the client will be using the talk box everyday as it will be attached to his wheelchair, it is important that the device is made of strong and durable materials.

3 Problem Definition, Concept Development, and Project Plan

3.1 Problem definition

1. List and prioritize client needs/problems and define all relevant known and unknown

information.

- Client has the following problems:
    - Non-verbal
    - Limited vision
    - Limited use of hands
- Needs:
    - Communication options
        - Words and phrases to choose from that will be spoken out of a speaker when selected (English or French)
    - Talk box should be red to accommodate for limited vision
    - Earbud for navigating UI by ear
    - Potentially braille on buttons?
    - Entertainment (potential)
        - Music, audio books, games, animal noises
    - Joystick for LEFT hand
    - Portable

2. Create a problem statement (what is the problem, who has the problem, and what form can the solution be).

Problem statement: There are those who have limited capability to speak, connect with music/auditory output, and miss out on the chances to experience the pleasure of listening to certain sounds under their control. We will create a Music Talk Box that will provide the opportunity for those who face these problems every day to still enjoy these experiences by providing an easy-to-use device that accommodates all of their disabilities. To accommodate visual limitations, we will make the talk box red so that it stands out. We will also provide an earbud for the user to navigate through the talk box UI by ear. For physical limitations and limited hand movement, we will make the primary form of navigation through the talk box UI a joystick. Those that are nonverbal or have communication limitations, will be able to communicate via the talk box by having a variety of words and phrases to choose from, which will be spoken through a speaker when selected.

3. Provide a list of need-inspired metrics with appropriate units, and conduct benchmarking on similar solutions (can satisfy some or all needs). Provide descriptions and pictures when possible.

Inspired Metrics	**Units**

Weight of talk box	Kg
Screen size	mm^2
Size of joystick	Cm^3
Weight of joystick	Kg
Raspberry Pi Board Size	Cm^3
Raspberry Pi Board Weight	g
Cost	$CAD

4. Develop a set of target specifications (both ideal and marginally acceptable values). Provide reasons for your choices.

Inspired Metrics	**Target Specifications (Units)**
Weight of talk box	1Kg - Light weight required for portability
Screen size	$30mm^2$ - To aim for better portability, the screen should not be too big.
Size of joystick	15cm x 10cm x 10cm - Smaller size for portability
Weight of joystick	1Kg - Light weight required for portability and ease of use
Raspberry Pi Board Size	10cm x 6cm x 1.5cm - Small size to accommodate a small talk box shell for portability.
Raspberry Pi Board Weight	50g - Light weight is better for portability and ease of use.
Cost	$100 CAD - Strict budget

3.2 Concept development

In our team, we have chosen to address the problem by developing a functional prototype that meets most of our client's requirements. Based on the information available to us at present, we will try to minimize constraints in the following ways:

Limited Vision:

1. Case in a bright red color to make it easily distinguishable from other objects.

2. Implementation of a user-friendly interface with large, Bold characters and a distinct background with colors suitable for individuals with reduced vision.

3. Audio output connected to an earbud, providing continuous vocal guidance to assist the client throughout their navigation.

Limited Mobility:

The device will be equipped with a joystick and three control buttons designed for easy pressing, maximizing comfort in device usage.

Limited Verbal Expression:

1. An integrated audio speaker will serve as external communication for the selected phrase or music chosen by the client.

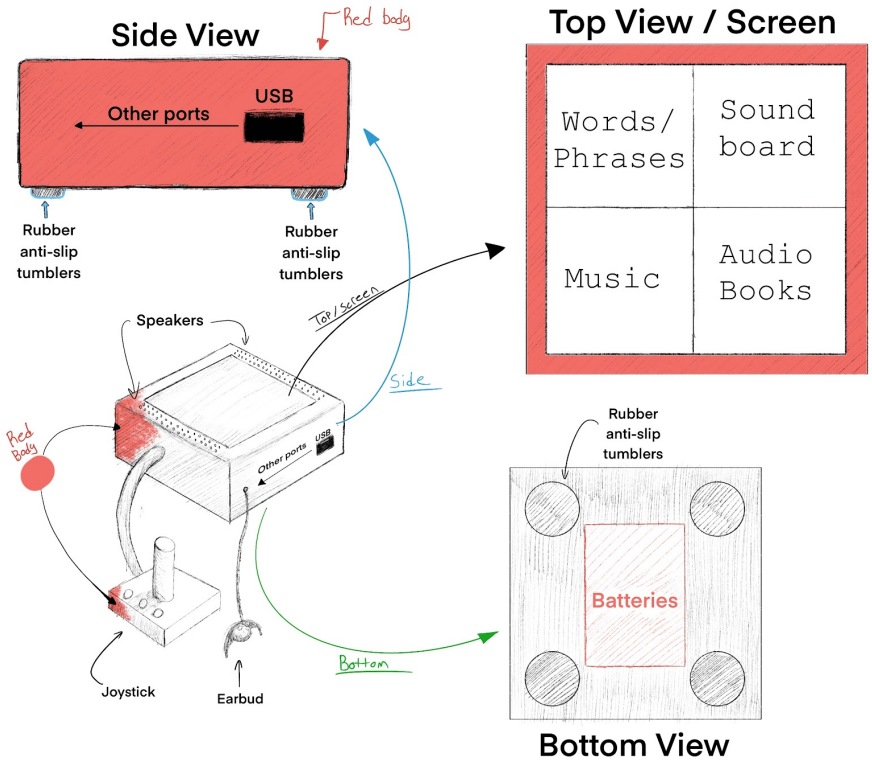
2. The user manual will provide the option to add other words/phrase, allowing family members to supplement communication needs and eliminate as many communication constraints as possible.

Sub Systems

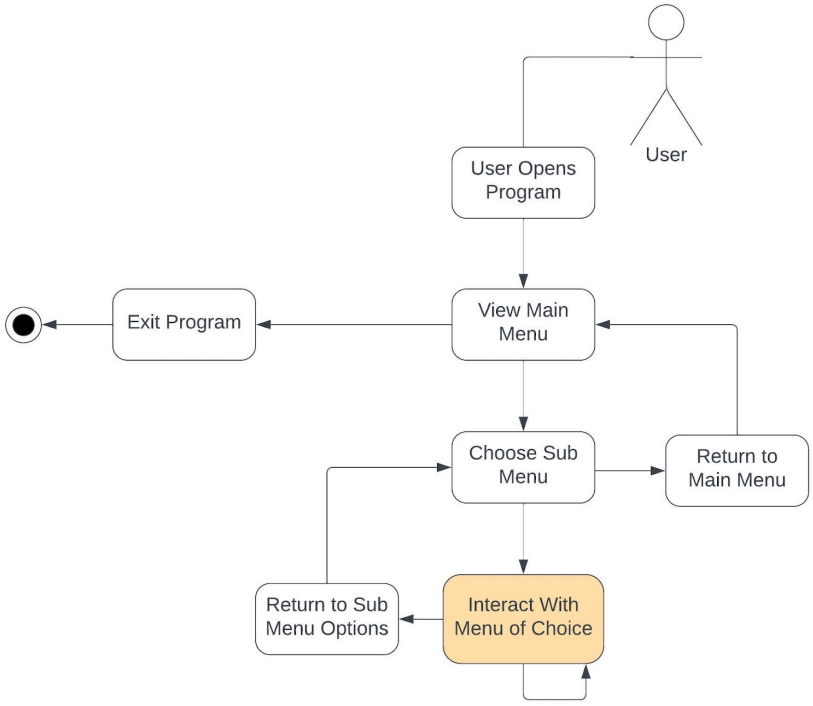
Sub-System	**Ideas**
LCD Screen	A single LCD screen with a simplistic and minimal UI.
UI Navigation Via Audio (Text to speech)	Users will be able to navigate the UI by ear. We will accomplish this by providing a small earpiece that will read out the elements that are currently selected on the screen.

Physical UI Navigation	Users will use a joystick to navigate the UI with minimal movement required. To select options the user will press a button.
Communication/Media	For communication, the user will select from a variety of words/phrases that will have text to speech implementation. When a word/phrase is selected, it will be read out by the Talk Box via the integrated speaker. For any other media, we will have different submenus developed for each section (music, soundboard etc).
Portability	The Talk Box will have a 3D Printed shell covering the internal raspberry pi board. This shell will be minimal and small enough so that the user can take it with them anywhere. To ensure the Talk Box is stable on a wheelchair tray, the talk box will have rubber, anti-slip tumblers on the bottom of the shell.

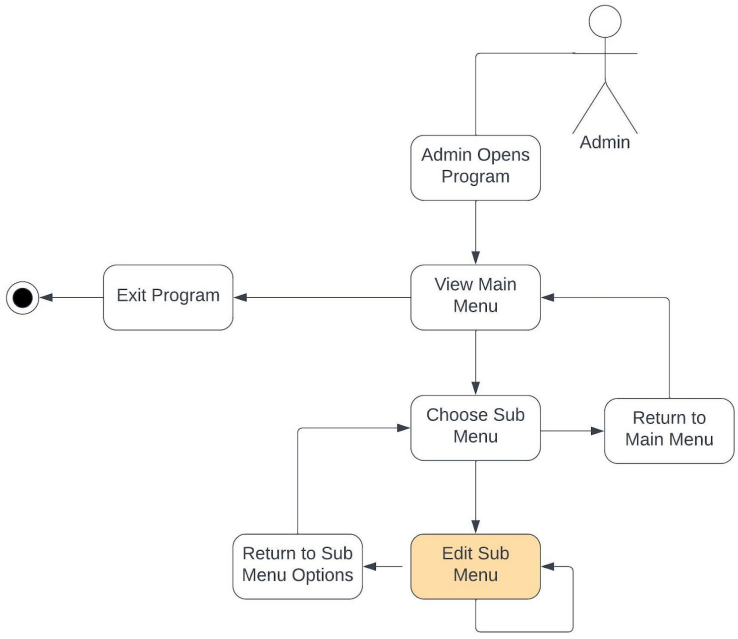
Global idea of the device's outlook:



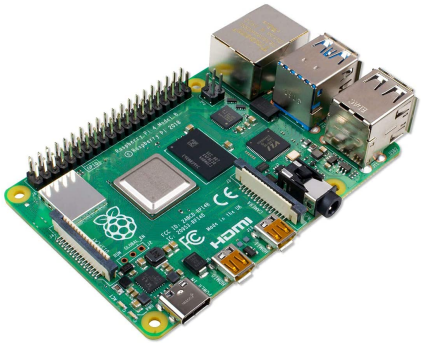
User Interface UML Design



Admin Interface UML Design



Device’s Hardware:



-Raspberry pi 4 : would serve as the main processing and external system manager

- 3.5 ~5 inch Display: it will be integrated to the device as the visual output

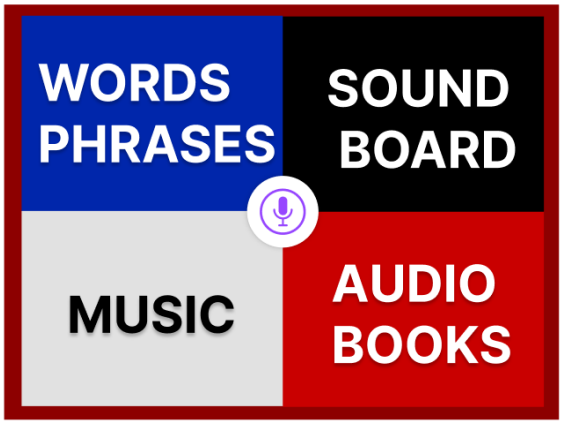
– 3d customised red case : a blueprint will be designed and printed using the uottawa's university 3d printers.

- Speakers: will be used to output the users selected choices (words/phrases, sounds, etc)

Software :

A customized software will be implemented and integrated into the device.

Main and secondary UI will be implemented following this style.



Please note that the content of the menu will be more than the ones shown in these images.

Our proposed concepts address our client's mobility and visual impairments and fit within our allocated budget of $100. They are also finishable within our timeframe and amongst our team of four. A benefit of our design is its relevance to our respective degrees, being software, mechanical, and electrical, which gives us confidence in the work we have done and have yet to complete. A drawback of this is any components that fall out of areas of expertise may be overlooked, such as the cosmetic appeal of our application.

3.3 Project plan

https://www.wrike.com/workspace.htm?acc=6263070&wr=20#/folder/1203894344/timeline3?viewId=199165465

4 Detailed Design and BOM

4.1 Detailed design

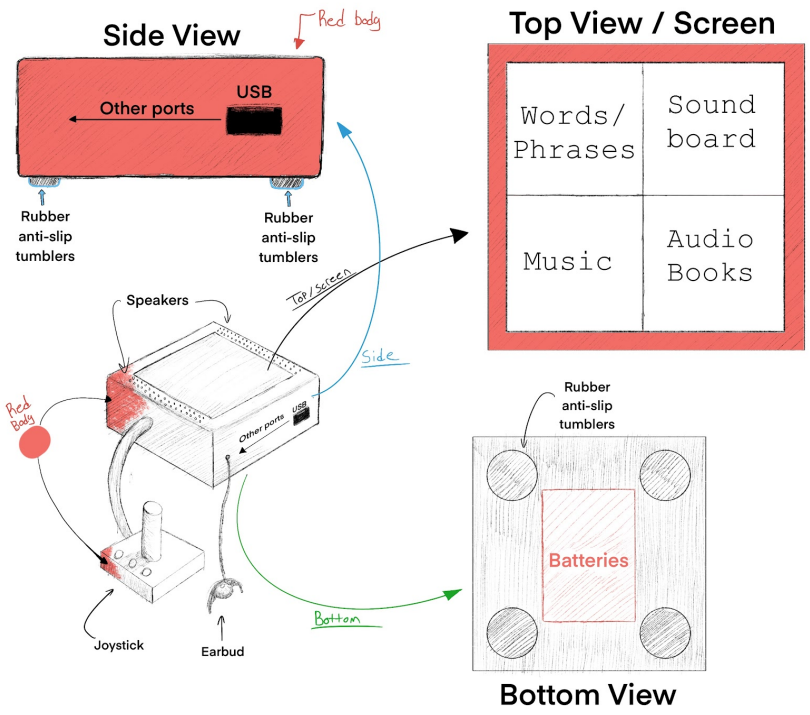
Summarized Client Feedback:

The client made us aware of a new obstacle that will have to be tackled, and that is to work around her son's new pacemaker. This pacemaker must stay away from the electromagnetic field. This will be a big thing to consider since this project consists of a lot of technology which may pose a problem.

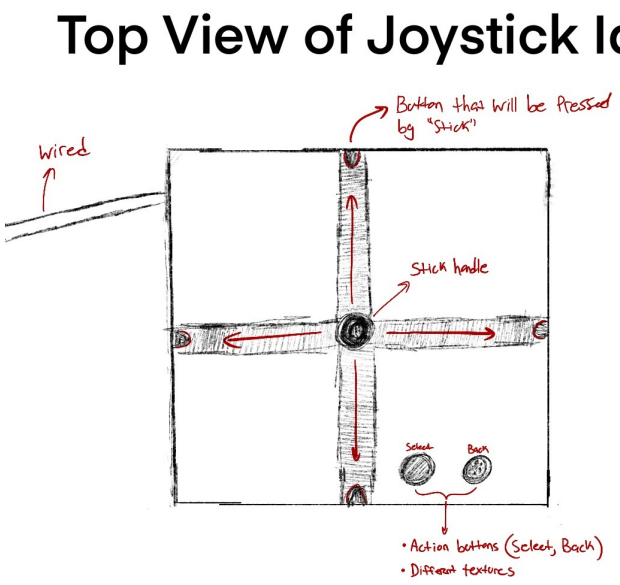
She specified that for the words and phrases available on the device she wants an emphasis on phrases describing pain/discomfort, and asking for help. **She will provide us with a list of words/phrases.**

She also mentioned after seeing our initial joystick idea that she would prefer a bigger joystick for ease of use, and preferably with built in buttons. However she liked our idea with the buttons where Red would be for Select, and a secondary button (colour not specified) as a Back Button.

Physical Prototype (Talk Box):



Physical Prototype (Joystick):

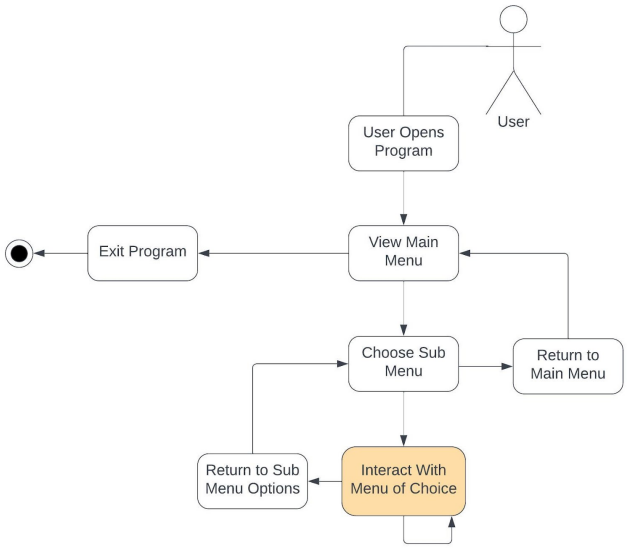


Sub-Systems:

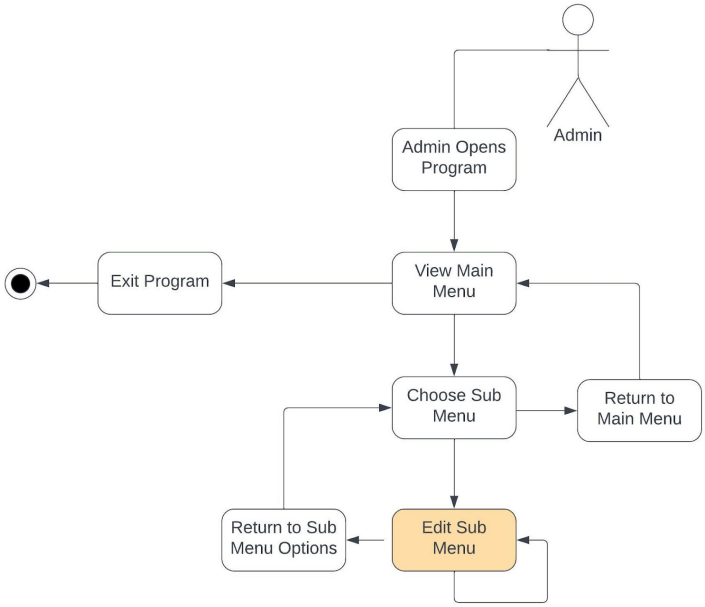
- Joystick: is directly related to the main system (Talk Box) as it is what the client will use to interact with the Talk Box UI
    - rather than having two buttons for Select and Back, we will have left movement for Back, right movement for Select, and up and down for navigating the UI
- LCD screen: though the client has limited vision, the screen is important for those around him who will help the client learn how to use the Talk Box. It is also useful for development as we can organize the UI as needed. Has Back and Select buttons.
- Speakers: the sub-system that will output any audio required (words, phrases, music, sounds, etc)
- Rubber anti-slip feet: To stop the Talk Box from sliding on the wheelchair tray
- Software:
    - Text-to-speech: Used to output selected words and phrases. Will also (potentially) be used for UI navigation for client due to limited vision
    - UI: Will include the main menu, which will lead to sub menus based on selection. Sub menus will have different options to select on based on the menu (words/phrases music, etc)
    - Admin: Admin can add/delete words and phrases

Software Prototype:

User Interface UML Design



Admin Interface UML Design



Provide a detailed list of skills and resources you have at your disposal that will enable you to create your design. If there are skills or resources missing to complete your design, describe how you will obtain them.

- Programming skills - Raspberry Pi
    - C# is being learned from research and online tutorials
    - Navigating how to use Raspberry Pi will be learned from research and online tutorials
- Resources:
    - Raspberry Pi - will have to be purchased
    - LCD Screen - will have to be purchased
    - Battery Pack - will have to be purchased
    - Buttons - will have to be purchased
    - 3D Printing - provided by University of Ottawa
    - Visual Studio - free IDE

Provide a realistic assessment of the time required to implement your design and the actual time your group and its individual members have at their disposal

Item	Expected Time to Complete
Operating system	Already completed
Physical design planning	~4 hours
Creation of physical components (joystick, buttons, etc)	~5 hours
Connecting all components (software, controls, etc)	~2 hours
Troubleshooting	~4 hours
Adding improvements at the client's request to present amongst the final product	~8 hours

Seeing as we have until the end of the semester (approximately) to finish our project, and we have an estimated 23 hours of work until completion, we can do some calculations to assess if we will finish promptly and without our other, individual time commitments suffering.

Each one of our members is expected to devote two hours per week to the actual creation of our project. With four members, eight hours will be allocated each week to the project's completion. Therefore, we should have our project done around three weeks from today (October 17). Of course, that is a hopeful estimate, but that time frame is tight enough to allow us to make any adjustments that might extend that window toward the very end of the semester.

Define any other critical product assumptions that could affect your ability to implement your design. For example: the acceptable values for a specification, availability of material/component, or a critical functionality.

A critical product assumption that, if false, could jeopardize our design, is all our components being compatible together. That is, the software we have chosen to use works seamlessly with the electrical components of the joystick and buttons that we must build, all of the feedback can be transmitted to our display, and more. The best-case scenario in the falsehood of this assumption is that we must modify our program slightly; the worst-case scenario is that we must completely overhaul our program to work with the designs we have built. That can add a lot of time to our project which will be spent learning the workings of a new programming language or framework.

4.2 BOM

Item Name	Description	Quantity	Units	Unit Cost (CAD)	Was it bought?
Raspberry Pi	Low cost small computer that plugs into devices and runs the program.	1	1	$55.00	**Yes**
Battery Pack	Portable, chargeable battery pack, has the required amount of power needed for Raspberry Pi	1	1	$33.89	**Yes**
Small speaker	Speaker to play out the users selected options	1	1	$8.25	**No**
3D printed Shell (Raspberry Pi)	3D printed case to protect the talk box and hold components together	1	1	$0.00	**N/A**
3D printed Shell (Joystick)	3D printed case to protect the joystick	1	1	$0.00	**N/A**
LCD Screen	flat panel which uses liquid crystals to display	1	1	$29.93	**Yes**
Joystick	Device to be used by the client to navigate the UI	1	1	$29.37	**Yes**
Micro SD Card - 16gb	Storage used for Raspberry PI, required to boot up OS	1	1	$12.42	**Yes**
Wireless Earpiece	Device that will output the text-to-speech navigation for the user.	1	1	$4.98	**No**
Non slip pads	To be placed under the talk box and	1	16	$4.44	**No**

	joystick to keep them from sliding on the wheelchair tray				
Visual Studio Code (.NET C#)	IDE of choice to develop the Talk Box UI and functionality	N/A	N/A	$0.00	**N/A**
				Total: $178.28	

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/FANTIA-Speaker-Portable-Outdoor-Android/dp/B0C8SFFPMT/ref=sr_1_8?keywords=Mini+Portable+Speaker%2F3.5mm&qid=1700767652&sr=8-8
Wireless Earpiece	https://www.walmart.ca/en/ip/Bluetooth-Headset-Wireless-Earpiece-V5-0-35-Hrs-Talktime-Hands-Free-Earphones-Noise-Cancellation-Mic-Compatible-iPhone-Android/1H9FGU41K9TA?from=/search
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
Joystick	https://www.amazon.ca/dp/B07BN97FN8?psc=1&ref=ppx_yo2ov_dt_b_product_details
Micro SD Card	https://www.amazon.ca/dp/B074B4P7KD?psc=1&ref=ppx_yo2ov_dt_b_product_details
Visual Studio Code (.NET C#)	https://visualstudio.microsoft.com/vs/

4.3 Project plan update

https://www.wrike.com/workspace.htm?acc=6263070&wr=20#folder/1203894344/timeline3?spaceId=1203894342&viewId=199165465

5 Prototype 1, Project Progress Presentation, Peer Feedback and Team Dynamics

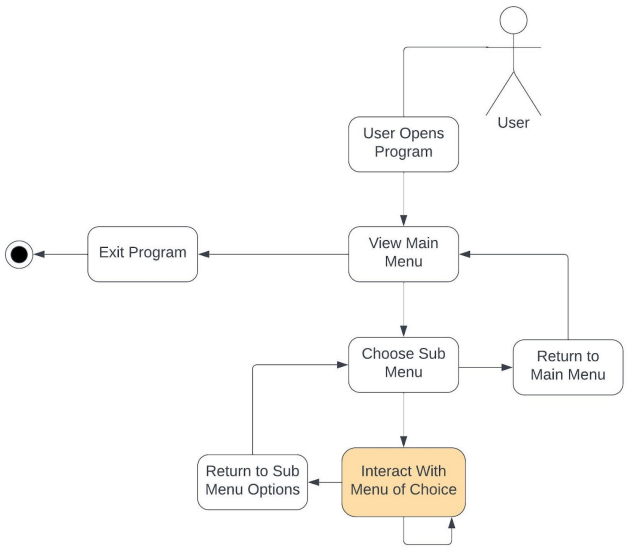
5.1 Prototype 1

The first prototype we have created is for the operating system of our device, which is its most crucial component. We have developed this prototype as a Windows Forms application, using Visual Studio as an integrated development environment and C# as our programming language. These tools required no budget. The program it allowed us to develop can be seamlessly transferred to a physical presentation, using a Raspberry Pi device connected to a display.

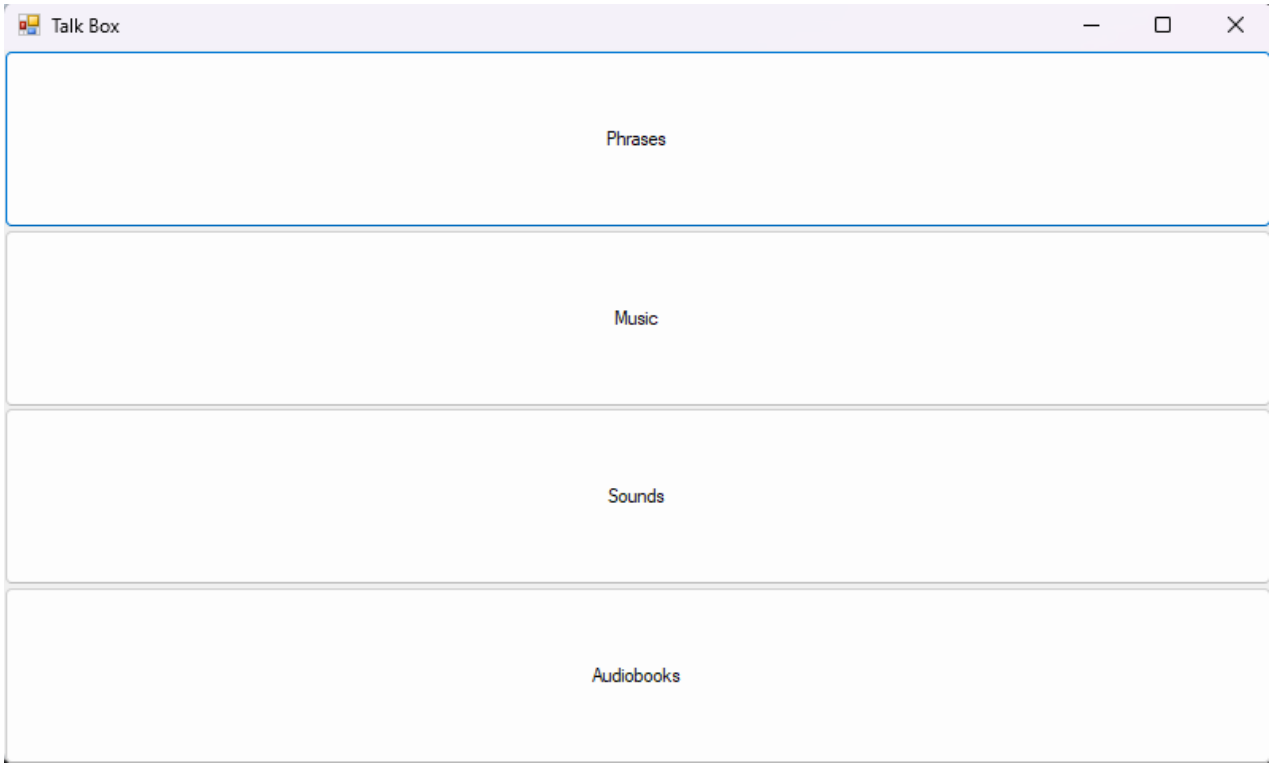
The assumptions of our final prototype that we aimed to validate with our program are as follows:

1. It will feature text-to-speech integration.
2. It will have a modifiable user interface.
3. It will contain four main selections of media: phrases, sounds, music, and audiobooks.
4. Media can be added and removed.
5. It will follow the UML design we presented in Deliverable D.

We will now present a walkthrough of our program using screenshots, explaining the functionalities at each step. You can find our aforementioned UML design again below, for reference.



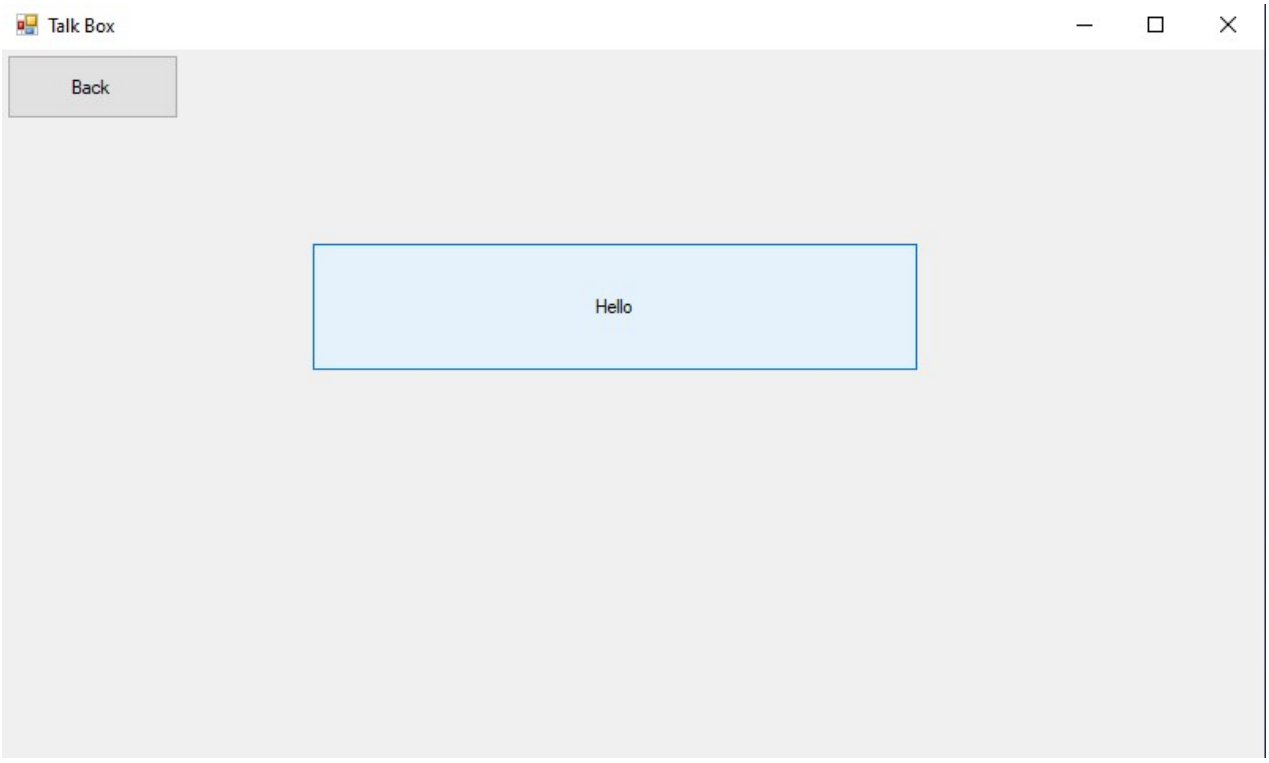
User Interface UML Design



Main Menu

The user will view the main menu when they first open the program. As you can see, our four chosen sub-menus - phrases, sounds, music, and audiobooks - are visible and ready to be selected. The user interface is modifiable at our discretion, should our client require specific visual accommodations. The program can be exited at any point, using the 'X' at the top right corner of the window. Hovering above any option will have its text played out, which will be apparent during our lab presentation where we will demonstrate a live demo.

Now, let us click any of the above options. If we click 'Phrases,' the following screen will be shown.



'Phrases' Sub Menu

Here, the user will be able to select a variety of speech options. For simplicity's sake, we have only included the word "Hello" to test its functionality. But words and other audio options can be added and removed easily. Selecting 'Back' at this point will send the user back to the main menu and selecting 'X' will exit the program.

All the other sub menus will feature an identical design.

As you can see, all assumptions have been validated. Text-to-speech has been integrated, the user interface is modifiable, all sub-menus are present, media can be added and removed, and the UML diagram is fulfilled. Since we are not dealing with quantifiable measurements, we cannot provide any numerical values. But our actual results are our expected and desired results.

5.2 Project Progress Presentation

https://docs.google.com/presentation/d/1Qjt8yla5YjlyLLCP0R8LuITgMpmVlZyK8dgtxTU_ITU/edit?usp=sharing

Wrike Updated Project Plan:

https://www.wrike.com/workspace.htm?acc=6263070&wr=20#folder/1203894344/timeline3?spaceId=1203894342&viewId=199165465

6 Design Constraints and Prototype 2

6.1 Design constraints

1. Identify two non-functional design constraints that play an important role in the

development of your prototypes. Justify your reasoning.

Constraint 1: Our client has many limitations and disabilities. The most notable limitation is his vision. This is a non-functional constraint because it requires us to find a solution for the client's limited ways of interacting with the user interface visually.

Constraint 2: In our second client meeting, we were informed of a pacemaker implanted in our client's neck area. This constraint played an important role in the development of our prototypes because it forced us to change our initial design and the place where the talk box would be kept on the wheelchair.

2. For each design constraint, explain in detail what changes would need to be made to

your design to satisfy the constraint.

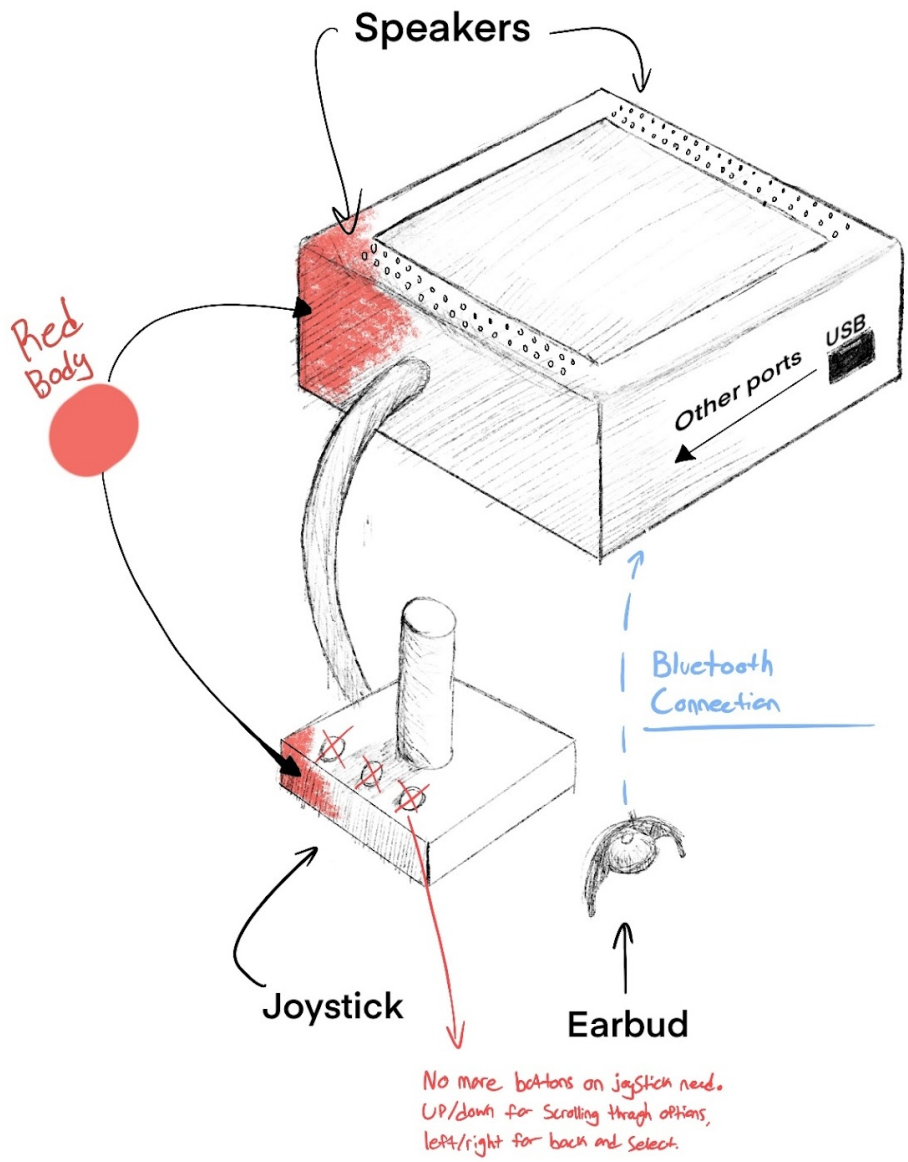
Constraint 1: For the first constraint, there were many changes that needed to be made. Firstly, we needed to implement a text-to-speech system so that the client could interact with the interface more easily and effortlessly. When the user navigates through the joystick interface, the text-to-speech system will announce what menu the user is hovering over through an earbud. For example when the user goes over the section "music", the text-to-speech code will read out the word "music" to the client so that he can easily interact with the interface. Secondly, since our client is not completely blind, he still has the ability to interact with the interface visually. The user's mother mentioned that red is the preferred color as the contrast is crucial for her son's visual limitations. Therefore we will not only implement the text to speech, but we will also display the menus in red. This will allow the user to interact with the talk box easily.

Constraint 2: We needed to change our initial design to keep the talk box away from our client's neck as it is dangerous to have devices close to the magnet in his neck. After communicating with our client we figured that the wheelchair tray would be at a safe enough distance to not interfere with the user's pacemaker. We then needed to make sure that the device would be secure on the tray so that it does not fall off when the user is rolling his wheelchair. We decided to add non-slip rubber pads to the bottom of the device.

3. Provide proof (e.g. analysis, simple calculations and/or simulations, research) to

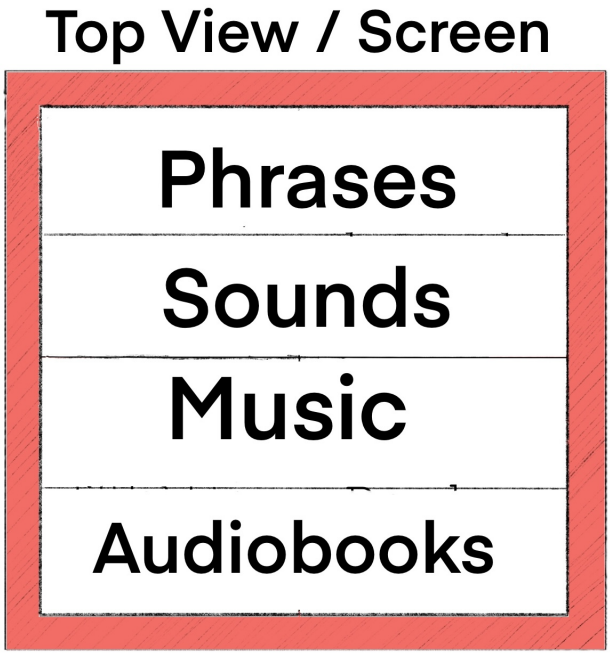
demonstrate the effectiveness of your changes in satisfying the constraints. Justify the process and methods you used.

4. Update your detailed design accordingly. **(3 and 4 combined)**



In this updated design, we showcase the new joystick implementation, where instead of having buttons for select and back, we will make use of the 4 directions that will be used. Left/Right will be for back/select, and up/down will be for navigating the menu options. Not only does this simplify the programming we will have to do, but it will also be easier for the user they have limited control of their hands. We believe that not having to switch between the joystick and the buttons will be more intuitive for the user.

We also show the use of a bluetooth wireless earpiece for the text-to-speech navigation. This change is to take into account the pacemaker that the client recently got, and will mitigate the risks that a wired earbud would pose.



This is the new screen design of the UI that is meant for the new joystick implementation. Since up/down is now just for navigating the menu options, the menu options are now in a stacked view. For more detailed images please see 6.2.

6.2 Prototype 2

1. Summarize any new client feedback that you have received or any new testing results and clearly state what needs to be changed or improved in your design. Update your detailed design accordingly.

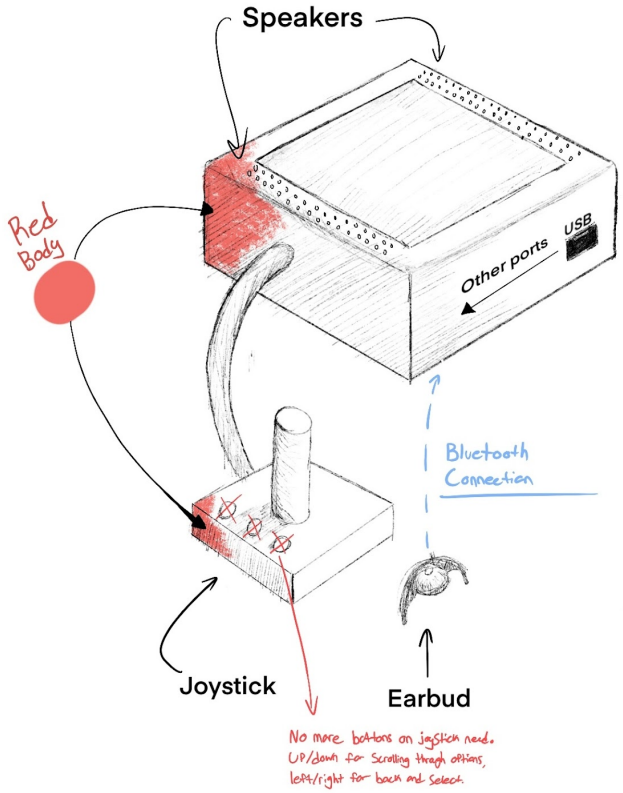
So far we have not fully completed our full prototype and we also did not get the chance to show the client our progress with our program, therefore we don't have any feedback that directly relates to our prototype. We are currently waiting to confirm the safety of using a wireless earbud for our design due to the client's pacemaker. Our client's mother said she is discussing with someone at CHEO to get more information. At the moment the client's

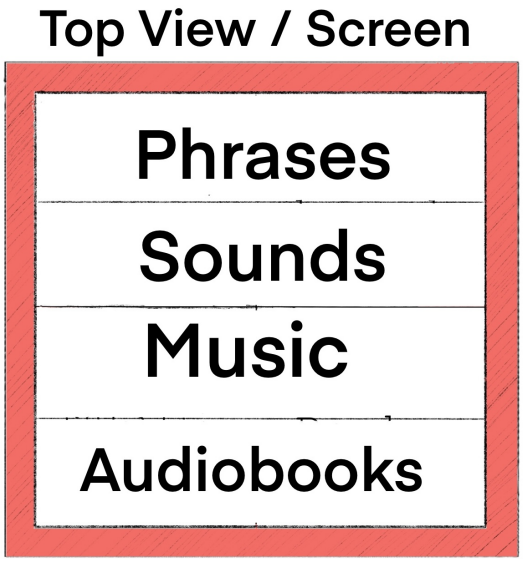
mother has said that a wireless earbud is most likely the best option. We will discuss further with the client in the next meeting to confirm the next course of action.
So far we have a base program completed and we are in the process of formatting the words and phrases menus that the client will choose from.

2. Define the most critical product assumptions that you have not yet tested.

As we are finishing the softwares features we have not yet tested the features once integrated into the raspberry pi and testing how fast and easily the device will be working in real life and on physical hardware.
Once this phase is done we will be focusing on the user friendly interface that will improve the interactions with and fast familiarisation with the device.
All along these major processes we will keep in mind the safe distance that the device can be placed according to our client's feedback and adjust our design accordingly in terms of output volumes, earbuds usability, screen lightness and contrast .

3. Develop a second set of prototypes that will help you on your way to creating your final prototype and test the critical product assumptions along the way.

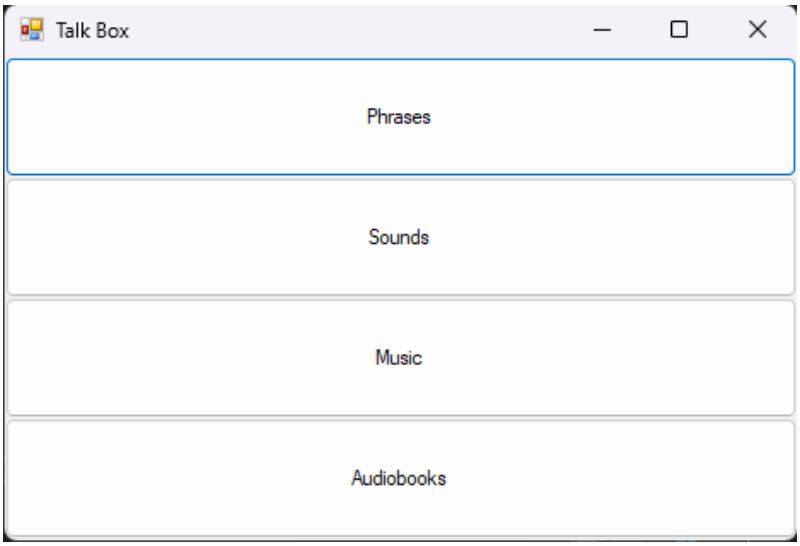




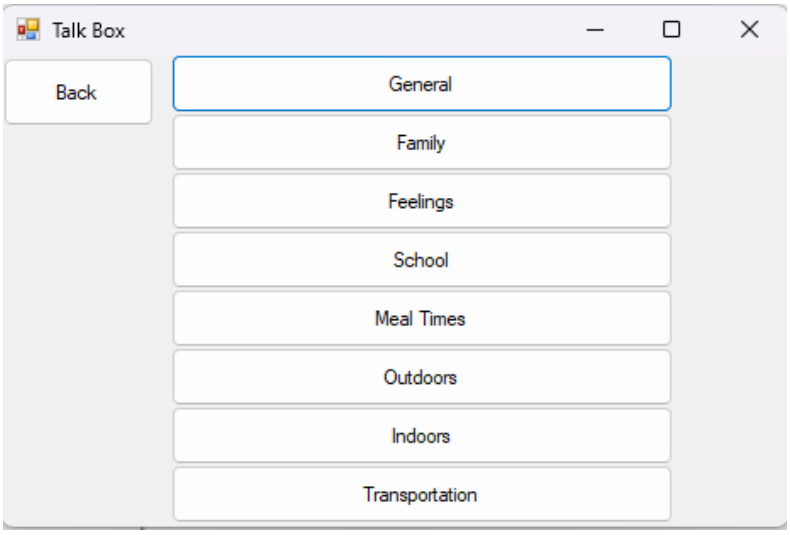
4. Document your latest prototype(s) using as many sketches/diagrams/pictures as required and explain the purpose and function of your prototype(s).

Current idea for talk box is still the same physically and we have not yet obtained all of our hardware. Because of this we were unable to start building a physical prototype, however we have made lots of progress with the software that will run on the Talk Box. Below are some screenshots of the current user interface, it will change as we add more options to each sub menu.

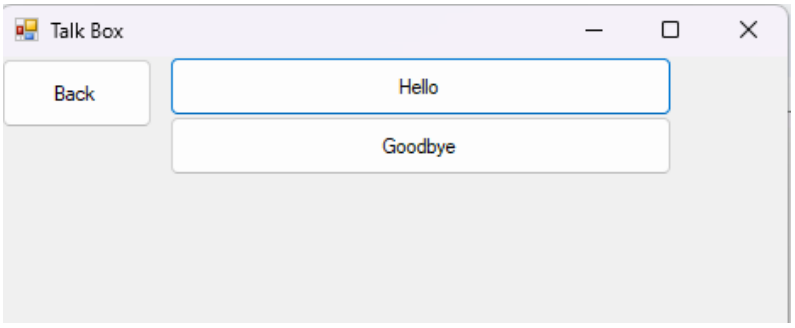
Main menu:



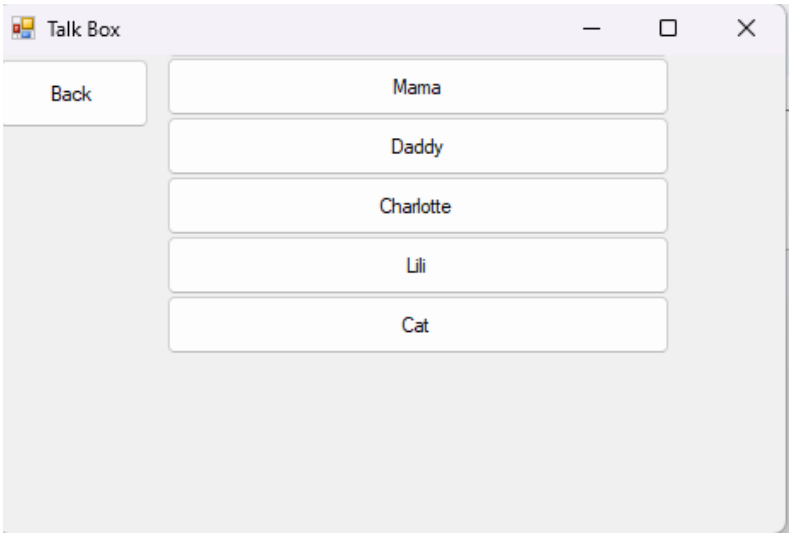
Phrases Sub-Menu



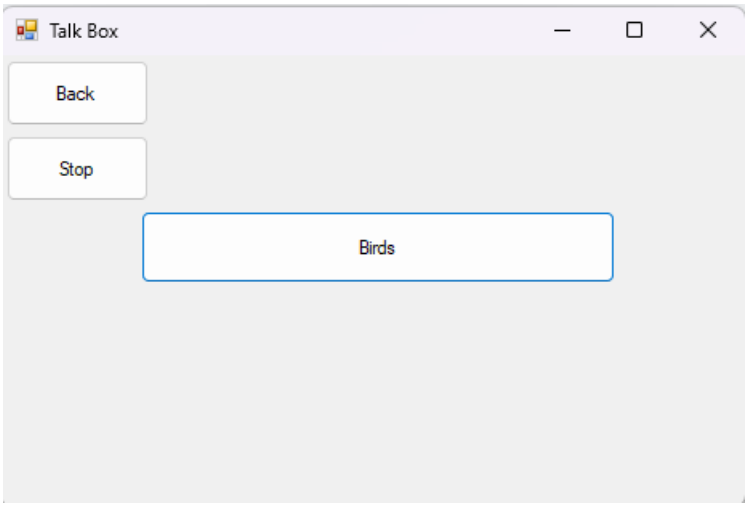
General Sub-Menu



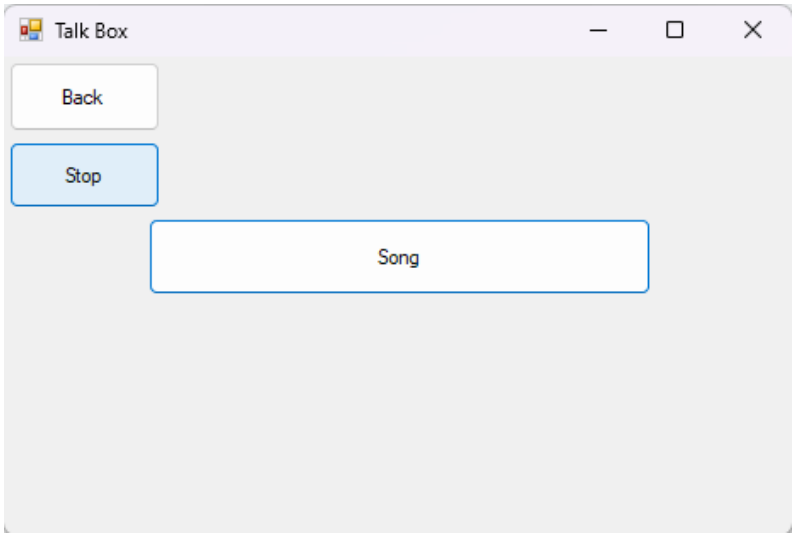
Family Sub-Menu



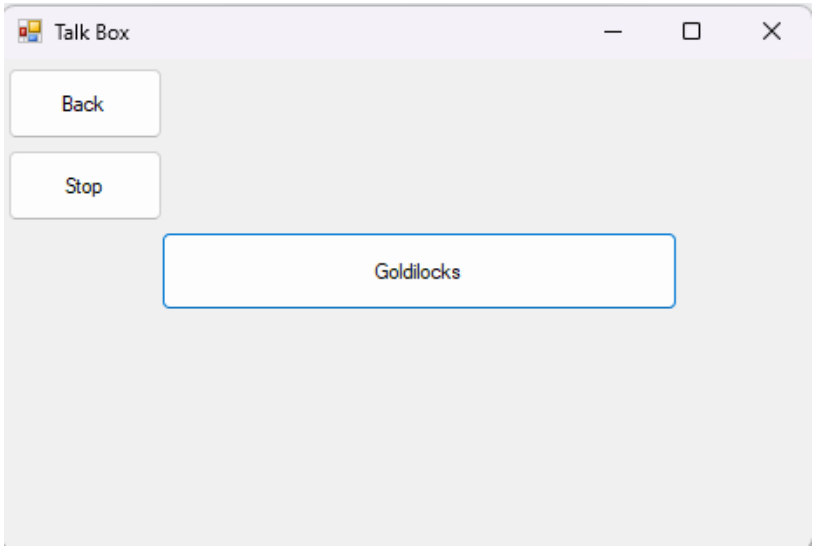
Sounds Sub-Menu



Music Sub-Menu



Audiobooks Sub-Menu



For every button the select box is focused on, the corresponding text will be outputted for the user to hear. This way the UI can be navigated via ear. We plan to confirm with the client if we are good to use a wireless earpiece for the text-to-speech navigation audio to go directly to his ear, while selected outputs will be straight from the speakers.

5. Carry out prototype testing, analyze and evaluate performance compared to the updated target specifications first developed in Project Deliverable C and document all your testing results and prototype specifications. Present your testing in an organized, tabular format that shows expected versus actual results (i.e. compare your measured prototype specifications to your target specifications by including both in a similar table to the one you developed for Project Deliverable C).

   Since we have yet to develop the physical prototype, we have no physical metrics to compare to the ones set in Deliverable C.

	Expected Results	**Actual Results**
Cost	$100 CAD - Strict budget	$104.90 (might vary)

6. Outline what your team intends to present to your client(s) and what information you would like to gather at your next client meeting.

. Software and features available that will be integrated into the physical product

. Collect the updated constraints status according to our client's needs.

. Review with our client's representative(his mother) our potential solutions according to the pacemaker constraint

. Collect new suggestions and ideas according to our client's need.

. Explain the global idea of how the design will be working and interacting with the user.

6.3 Project plan update

https://www.wrike.com/workspace.htm?acc=4975842&wr=20#folder/1214540664/list?filters=status%3Dactive&showDescendants=0&sortOrder=10&spaceId=-1&viewId=202244995

7 Other Considerations

7.1 Economics report

1. Include a list of variable/fixed, direct/indirect, and material/labour/overhead costs associated with your business, based on the manufacturing and sale of your product. Make sure that you distinguish between price and cost and realize that prototyping and higher-volume manufacturing costs will probably be different.

Variable Costs:

- Material: Raspberry Pi 4, LCD screen, Battery pack, joystick, plastic speaker, wireless earpiece, micro SD card
- Labour: Assembly labor (for putting together the Talk Box), testing and quality control labor, packaging labor

Fixed Costs:

- Equipment: Machinery for assembly and packaging machinery
- Facility costs: Rent for production space, utilities and insurance

Direct costs:

- Material costs (Raspberry Pi, LCD screen, etc.)
- Labour costs directly involved in assembly, testing, and packaging of the product

Indirect costs:

- Facility costs (rent, utilities, insurance)
- Equipment costs
- Administrative expenses
- Marketing and advertising costs

Overhead costs:

- Facility costs
- Equipment costs
- Administrative expenses
- Marketing and advertising costs

2. Develop a 3-year income statement, which includes sales revenue and costs of units sold for each year, gross profit, operating expenses and operating income (no need to include interest and taxes).

Year 1

- Sales Revenue:
    - Assuming we sell 5,000 units at $500 each.
    - Total Sales Revenue = 5,000 units * 500$ = 2,500,000$
- Cost of goods sold:
    - Variable costs per unit (material + labor) = 200$
    - Total cost of goods sold = 5,000 units * 200$ = 1,000,000$
- Gross profit:
    - Gross Profit = Sales Revenue - COGS = 2,500,000$ - 1,000,000$ = 1,500,000$
- Operating expenses:
    - Marketing & Advertising: 150,000$
    - Administrative Expenses: 100,000$
    - Total Operating Expenses = 150,000$ + 100,000$ = 250,000$
- Operating income:
    - Operating Income = Gross Profit - Operating Expenses = 1,500,000$ - 250,000$ = 1,250,000$

<u>Year 2</u>

- Sales Revenue:
    - Assuming there was an increase in demand, selling 10,000 units at 480$ each.
    - Total Sales Revenue = 10,000 units * 480$ = 4,800,000$
- COGS:
    - Assuming stable variable costs per unit at 200$.
    - Total COGS = 10,000 units * 200$ = 2,000,000$
- Gross Profit:
    - Gross Profit = Sales Revenue - COGS = 4,800,000$ - 2,000,000$ = 2,800,000$
- Operating Expenses:
    - Assuming a proportional increase in expenses.
    - Marketing & Advertising: 200,000$
    - Administrative Expenses: 120,000$
    - Total Operating Expenses = 200,000$ + 120,000$ = 320,000$
- Operating Income:
    - Operating Income = Gross Profit - Operating Expenses = 2,800,000$ - 320,000$ = 2,480,000$

<u>Year 3</u>

- Sales Revenue:
    - Once again, we assume that there was a increase in demand, selling 15,000 units at 470$ each.
    - Total Sales Revenue = 15,000 units * 470$ = 7,050,000$
- COGS:
    - Assuming stable variable costs per unit at 200$.
    - Total COGS = 15,000 units * 200$ = 3,000,000$
- Gross Profit:
    - Gross Profit = Sales Revenue - COGS = 7,050,000$ - 3,000,000$ = 4,050,000$

- Operating Expenses:
    - Assuming a proportional increase in expenses.
    - Marketing & Advertising: $250,000
    - Administrative Expenses: $150,000
    - Total Operating Expenses = $250,000 + $150,000 = $400,000
- Operating Income:
    - Operating Income = Gross Profit - Operating Expenses = $4,050,000 - $400,000 = $3,650,000

3. Using a NPV analysis, determine the break-even point (i.e. number of units that must be sold for your business to become profitable). Note: It is highly unlikely that your operating income will be positive in the first year because of fixed costs. Therefore, you must use a NPV analysis to compare costs and profits over multiple years based on present value. Draw two cash flow diagrams of the expenses and incomes for the next three years. Calculate the NPV value of each expense/income and determine the differences and then the break-event point.

Using NPV analysis, we need to calculate the total cashflow for each of the 3 years. We will need to compare the income with the expenses so that we can find the NPV.

Expenses:

- Year 1: -$727,273
- Year 2: -$669,421
- Year 3: -$685,584
- Total Expenses NPV = -$727,273 + (-$669,421) + (-$685,584) ≈ -$2,082,278

Incomes:

- Year 1: -$227,273
- Year 2: $1,900,826
- Year 3: $2,479,339
- Total Incomes NPV = -$227,273 + $1,900,826 + $2,479,339 ≈ $4,152,892

The break even point occurs during year 2.

4. Describe and justify all assumptions that you have made in developing your economics report. The assumptions must be factual based on a preliminary market research that you conduct in order to determine the amount of demand in your target market, the expected % of the market that you would own, and the unit price of your product based on a sound pricing strategy. Important note: we expect you to make many assumptions here. However, each assumption should be identified and justified using information you gathered from various sources. Provide references when using this information.

One of the assumptions made in our economics report is the increased demand for communication devices for individuals with verbal, visual, and physical limitations. This increase is due to a growing awareness of inclusivity and technological advancements. (Source: World Health Organization**).**

We also assumed that the initial 5% of the total potential market increased to 10% by the end of the third year. This is based on the comparision with similar devices/communication products either on or entering the market. (Source:https://reliefweb.int/report/world/global-report-assistive-technology).

Our device starts at $500 per unit, in the second year it reduces to $480 and $470 in the third year. After doing some research we found that this is a great strategy for maintain ther sales. Just like apple and other high tech companies do with their products, when every year they release a new iphone while dropping the price of all of the previous iphone to maintain profitability. (Source: https://scholarspace.manoa.hawaii.edu/server/api/core/bitstreams/17a32f89-765d-4c8b-a491-0da13c689c85/content).

Assuming our business is successful, the production of the device will increase. An increase in production will cause a 10-15% reduction per talk box by the third year. (Source: https://ca.insight.com/en_CA/content-and-resources/2022/data-analytics-in-manufacturing.html).

7.2 Intellectual property report

In the development of our project it is essential to consider the aspect of its own intellectual because our project even if at the macroscopic level it is entirely designed by our team it would be inappropriate to ignore the microscopic aspect of it and therefore we mean the hardware components of the device as well as the libraries that make up the operating system code.

Indeed, the components of our device which could violate intellectual properties are the raspberry pi which serves as the main computer for our device, the touch screen, the external form of the device as well as the text to Speech libraries used to communicate with the outside world.

If the designers of these components mentioned above have not been informed, the marketing or large-scale production of our device could be exposed to legal proceedings.

7.2.1 Similar Patents

7.2.1.A.US 2006/0069567 A1

Created by Steven N. Tischer, Atlanta, GA (US); Robert A. Koch, Norcross, GA (US); Dale Malik, Atlanta, GA (US)

This patent is about methods, systems, and products disclosed for translating text to speech. One such method receives content for translation to speech, identifies a textual sequence in the content, and correlates the textual sequence to a phrase. A voice file storing multiple phrases is accessed, with the Voice file mapping each phrase to a corresponding sequential string of phonemes. The sequential string of phonemes, corresponding to the phrase, is retrieved and processed when translating the textual sequence to speech.

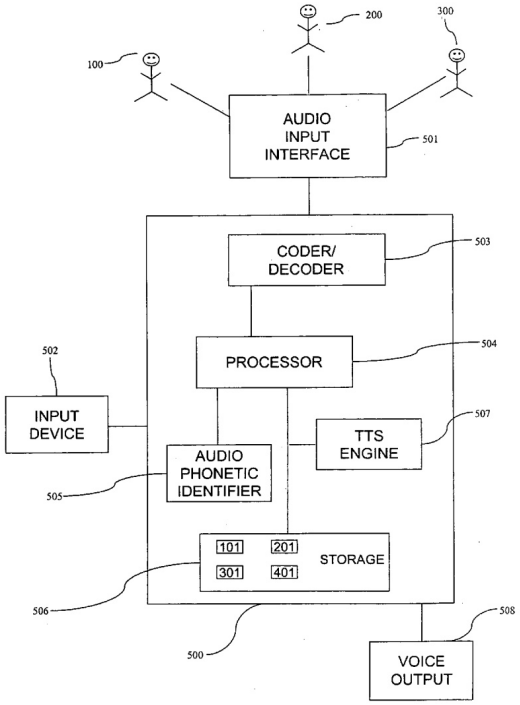


FIG. 15

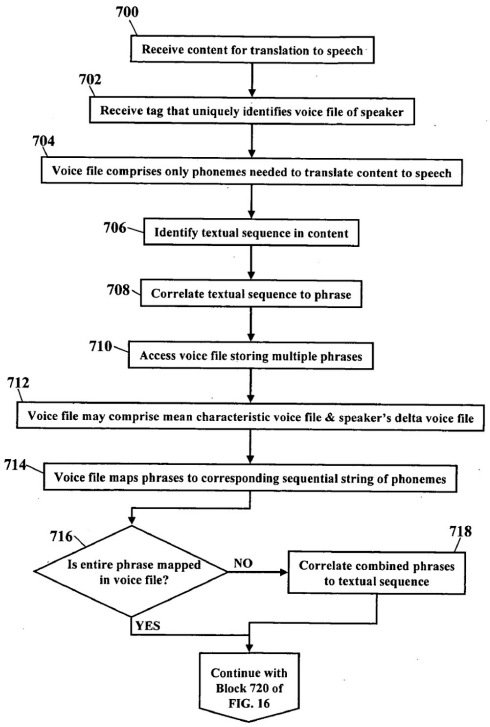
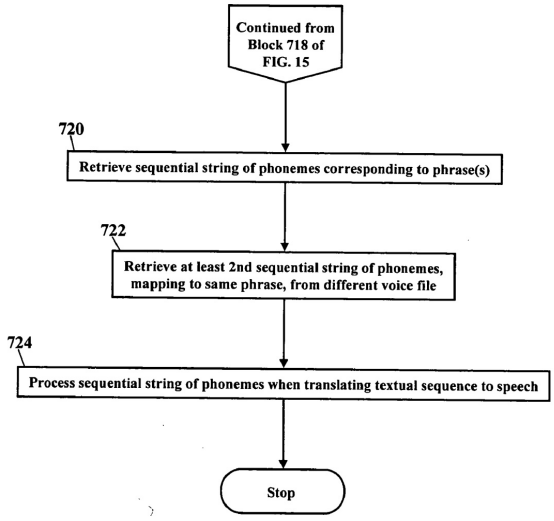

700
Receive content for translation to speech
702
Receive tag that uniquely identifies voice file of speaker
704
Voice file comprises only phonemes needed to translate content to speech
706
Identify textual sequence in content
708
Correlate textual sequence to phrase
710
Access voice file storing multiple phrases
712
Voice file may comprise mean characteristic voice file & speaker's delta voice file
714
Voice file maps phrases to corresponding sequential string of phonemes
716
Is entire phrase mapped in voice file?
NO
718
Correlate combined phrases to textual sequence
YES
Continue with Block 720 of FIG. 16

FIG. 16

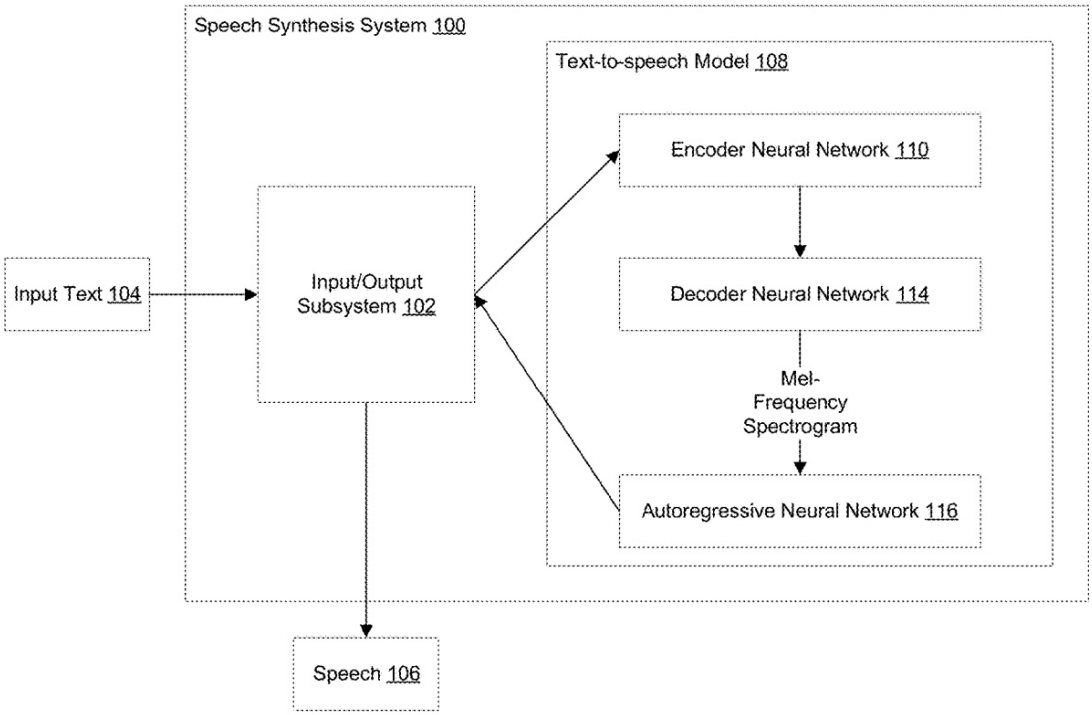

Continued from Block 718 of FIG. 15
720
Retrieve sequential string of phonemes corresponding to phrase(s)
722
Retrieve at least 2nd sequential string of phonemes, mapping to same phrase, from different voice file
724
Process sequential string of phonemes when translating textual sequence to speech
Stop

https://patentimages.storage.googleapis.com/42/a9/45/13eea3396e2853/US20060069567A1.pdf

7.2.1.B. US 2021/0295858 A1

Created by Yonghui Wu , Fremont , CA (US) ; Jonathan Shen , Santa Clara , CA (US) ; Ruoming Pang , New York , NY (US) ; Ron J. Weiss , New York , NY (US) ; Michael Schuster , Saratoga , CA (US) ; Navdeep Jaitly , Mountain View , CA (US) ; Zongheng Yang , Berkeley , CA (US) ; Zhifeng Chen , Sunnyvale , CA (US) ; Yu Zhang , Mountain View , CA (US) ; Yuxuan Wang , Sunnyvale , CA (US) ; Russell John Wyatt Skerry - Ryan , Mountain View , CA (US) ; Ryan M. Rifkin , Oakland , CA (US) ; Ioannis Agiomyrgiannakis , London (GB) and Applied by Google.

Methods , systems , and computer program products for generating , from an input character sequence , an output sequence of audio data representing the input character sequence . The output sequence of audio data includes a respective audio output sample for each of a number of time steps . One example method includes , for each of the time steps : generating a mel - frequency spectrogram for the time step by processing a representation of a respective portion of the input character sequence using a decoder neural network ; generating a probability distribution over a plurality of possible audio output samples for the time step by processing the mel - frequency spectrogram for the time step using a vocoder neural network ; and selecting the audio output sample for the time step from the possible audio output samples in accordance with the probability distribution.



https://patentimages.storage.googleapis.com/cc/99/7c/247b3c560a2b50/US20210295858A1.pdf

7.2.2. Possible Legal constraint

Based on the two intellectual property presented above it is obvious that the Talk Box could be Susceptible to legal action once on the competitive market since the functionalities desired in the talk box are already registered trademarks by certain companies. However, private and non-commercial use of the product would not be subject to intellectual property violations because the libraries used in our software are open source and signed non-commercial. Also our hardware does not have restrictions when it comes to for personal, non-commercial use.

7.3 Project plan update

https://www.wrike.com/workspace.htm?acc=4975842#folder/1214540664/list?filters=status%3Dactive&showDescendants=0&sidePanelItemId=1214540664&sortOrder=10&spaceId=-1&viewId=202244995

8 Design Day Pitch and Final Prototype Evaluation

Write your design day pitch and plan your prototype demo.

9 Video and User Manual

9.1 Video pitch

Add link to video.

9.2 User manual

See separate template for the user manual.

10 Conclusions

Summarize your lessons learned and your work related to your project. Discuss any outstanding issues or implications for the project.

11 Bibliography

Insert your list of references here.