University of Ottawa

Faculty of Engineering

GNG2101 Introduction to product Development and management for Engineers

Project Deliverable C

Submitted by:

Talk Box. C01, Team C13

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Abstract

The project “Talk Box” is being pursued because our group is looking for ways that are possible to help people that have disabilities, such as cognitive disorder and physical impairment, to be able to communicate with other people, and assist in automating daily activities as best as possible. The goal of this group is to analyze and design different core aspects of this project and make it into a realization

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1 Introduction

Group C13 is in the search of a design that can help many disabled people become as independent as possible in terms of executing their daily tasks. These activities vary from being able to access home gear such as TV's or thermostat by themselves, to being able to go outside and be able to communicate with people without relying on someone else. It is realized that the user's have very limited dexterity when it comes to interacting with devices. It is also known that disabilities cannot be generalized and so making sure the core design is versatile and easily upgradeable for different users is key.

2 Core Functionality Breakdown

The following table was created to create a clear image of each need. hence it was used as a guide to create the case diagram and the flow chart found in the next section

Table 1: Core Functionality Decomposition

#	Need	Imp	Functionality
1	Automate simple daily tasks *	5	The microcontroller can distinguish users presses (1 press, 2 presses etc) on the button to perform the desired task
2	Includes a simple dialogue commands	4	The microcontroller has a way of detecting that the user is in a conversation and responds by voice commands
3	Can produce sounds of multiple simple phrases	4	The microcontroller has a sound output system and allows the user to select the 10desired phrase output
4	Can access home devices e.g. TV, thermostat	3	The microcontroller accesses the network which then detects any smart home solutions and communicates with them via smart button to execute the appropriate task for the device
5	Can connect to Wi-Fi	3	The microcontroller will include a 2.4 Ghz network card/chip that allows it to connect to any Wi-Fi network that lies on the 2.4 Ghz frequency

6	Features can be customized by a separate user interface	4	A caregiver that has access to Talk Box interface and can customize it in a suitable manner for the disabled person
7	Includes Images/figures representing words/requests	3	Access images from storage that correspond to the word or sentence that is being selected by the user to be pronounced
8	Buttons require very low effort to use	4	Custom button actuation force should be used. For testing proposed a force sponsor can be used to adjust the activation force
9	Buttons are large and separated	5	Feasible button sizes based on user preference and distanced from each other based on user dexterity and distance of movement of their hand
10	Is resilient against physical damage from indoor and outdoor factors	2	No visible wiring between the button and the microcontroller. All components should be shielded from outdoors factors.
11	Supports different languages	1	The UI clearly shows ways to be customized to support multiple languages
12	Has an emergency contact feature	2	Contacts a caregiver while making a sound from the device itself. If alert goes on for longer than expected, calls police/paramedics
13	Is modular and can be upgraded down the line	5	Has I/O ports for hardware upgradability and is open-source software so it can be tweaked in the future

14	Is mountable on a wheelchair	5	By using bi-directional mounting brackets that can be used on either side of wheelchairs
15	Can be installed either side of a wheelchair	4	The mount design should be universally adaptable to all dimensions of wheelchair handles
16	Surfaces are smooth and comfortable for the palm of the hand	3	The materials and design of the button (the activation surface) must be comfortable for the user to press. All edges must be deburred
18	Uses wheelchair power to operate	4	The device has a power jack compatible with the user's electrical wheelchair
19	Is cost efficient/ inexpensive	5	The equipment and materials used are inexpensive

*Simple daily tasks

- turn the lights on/ off
- turn the heat up/ down
- turn on/off the TV
- ask for help
- express certain feelings ("I am cold", "I understand", "Thank you")

3 Functional Decomposition

In the following section the product functions are broken down into into smaller basic sub-functions while identifying external sub-system boundaries.

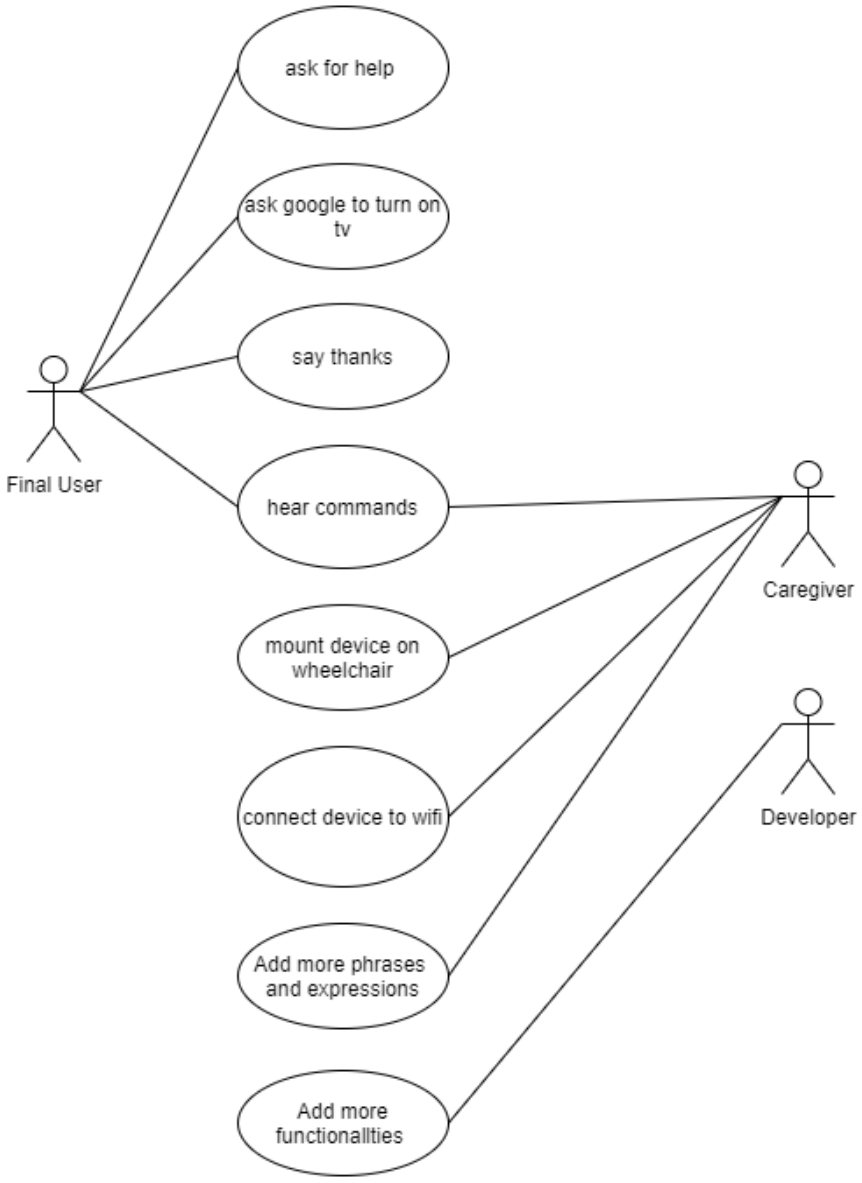


Figure 1: Case Diagram

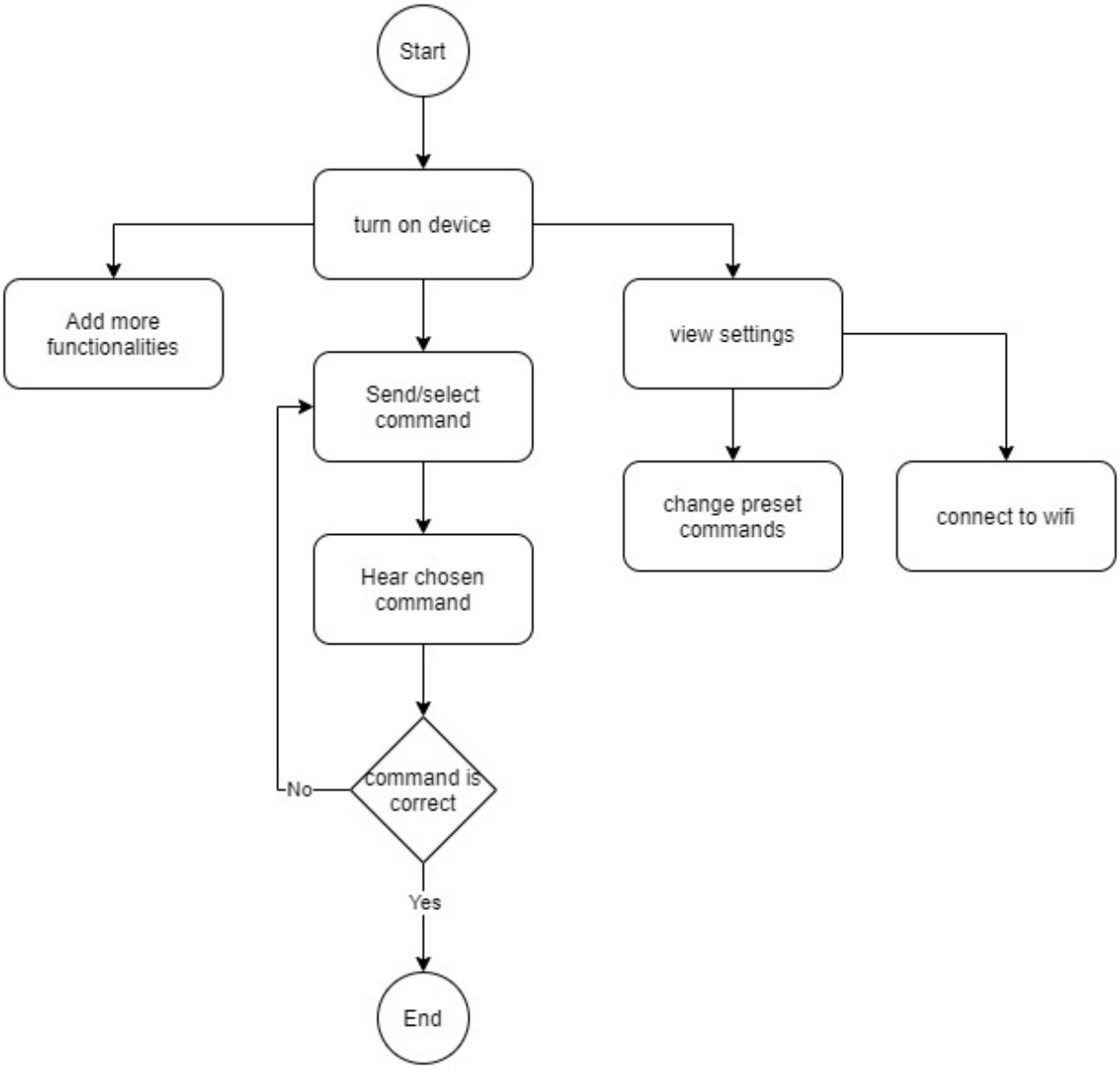


Figure 2: Flow Chart

Using the function decomposition, the team concluded that the promising solution will be divided into electrical communication , user interface, and button design and mount . Table 2 provides the solution category and the associated target specification. A table of the target specifications can be found in the appendices.

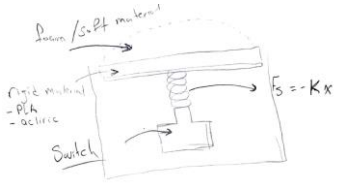
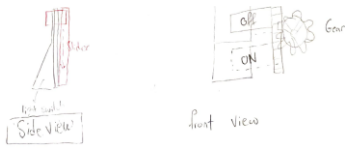
Table 2: Solution Category and Associated Target Specification Number

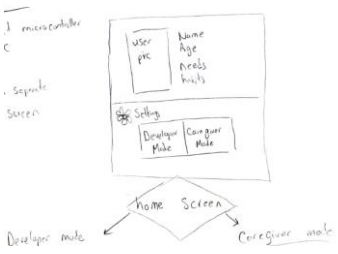
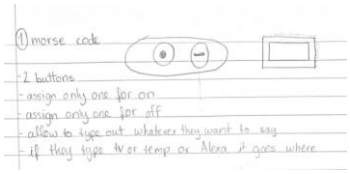
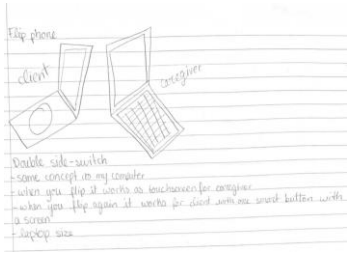
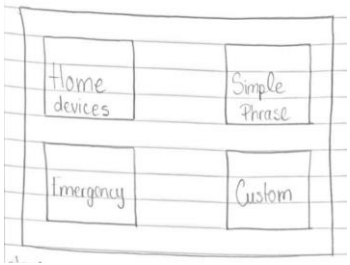
Solution Category	Associated Target Specification Number
Electrical Communication	1,2,3,4,17,19
User Interface	5,6,12,14
Button design and mount	7,8,9,10,15,16

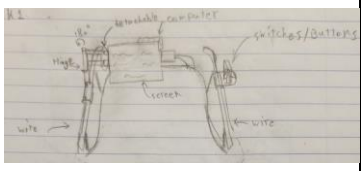
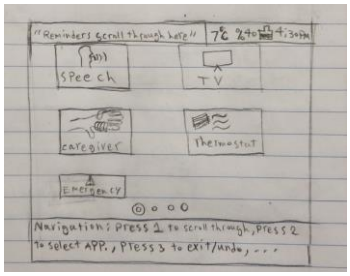
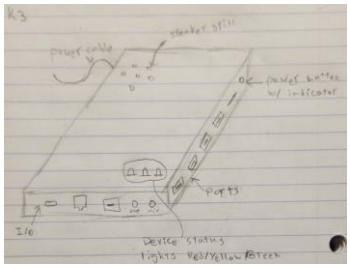
4 Proposed Design Concepts

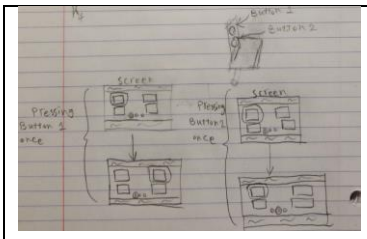
Each team member has spent the team to independently brainstorm and sketch ideas and concepts. A brief description of each concept is outlined in the table below.

Table 3: Sketches explanation

Z1) The Spring Switch 	The switch requires low force to activate. A spring (with a low stiffness constant) is used to decrease the activation force. Multiple springs can be used in series to expand the activation surface. A rigid material (PLA, acrylic) is placed on top of the spring, creating a constant force over the entire activation surface. Finally, a soft material (foam or cotton balls) to allow maximum comfort when pressing on the button.
Z2) The Function Slider 	A slider can be placed on the side of the button case to increase the number of functions available. For example, when the slider is in position 1, the first set of functions are performed, and when the button is in position two, the second set of functions are performed
Z3) The Light Switch Gear and Rack 	In order for our device to be compatible with non smart light switches, a mechanical system can be installed next to the light switch. The mechanism consists of a gear and rack, as the gear rotates the rack moves in a vertical motion. The gear is powered by a servo motor. Attached to the back of the rack is an arm that pushes on the light switch to turn it on and off.

Z4) Zee Web App Version 	A GUI that shows the user picture, name, age, needs, hobbits in the upper part of the home page. In the lower part of the home page, there is the developer mode or caregiver mode. If the developer mode is chosen, they are able to update device settings, edit current features, and create new features. If the caregiver mode is selected, they are able to drag and drop features in either by one click, two clicks, or three clicks.
T1) Morse Code Design 	This design is made up out of a controller with two buttons and a screen. There's one button with the symbol of a dash and one with the symbol of a dot. Each button also has a specific on/off function which activates and turns off the device. Using the same keypad, the client or the care-giver can type out whatever command or function they wish to perform using morse code. As they type, the sentence forms on the screen, once the user waits for a certain amount of time, it reads out the sentence, if it is correct they press either button, then that function is executed.
T2) Flip Phone Design 	This device behaves like a double-sided flip phone where on one side, it has a screen with one button which is aimed for the client. On the other side, there's a touch screen for the care-giver and developer. The one button allows the clients to select different options on his screen while the touch screen allows the care-giver to easily add new features just as they would use their smartphone.
T3) Interface 	This GUI has 4 categories: Home devices, simple phrases, emergency, and custom. The home devices section has all functions that belong to any functions done by home smart devices like the tv, the room temperature, Alexa/Google Home. The simple phrase section allows the user to choose from his day-to-day phrases that he uses quite often like: "Thank you", "I understand", "Please". The emergency section triggers an alarm/notification that alerts the care-giver. The custom section allows

	the caregiver to customize any of all the other sections whether to add functions or add phrases or change the emergency settings. The custom section also has room for the developer in case of more complex customizations.
K1) Wheelchair Mount  	An L shaped bracket is attached to the wheelchair where it offers 180 degrees rotation on its vertical axis and has a detachable horizontal proportion which allows for an easy and quick swap of the display. A separate mount for the button switch is used on the opposite side of the screen mount.
K2) Graphical UI  	A simple GUI powered by a separate screen module that updates the user about their essential needs and gives them easy access to assistive applications for their daily needs. There is essential information at the top of the screen such as daily reminders (i.e. calendar reminders, contact notifications, etc.) and updates about time, weather and power. The interface provides bold text and an image to go along with it for easy context understanding. At the bottom, an easy navigation description is given as to how to navigate throughout the UI.
K3) Computer/ Microcontroller  	An idea of what the computer in its case would look like. It provides ample amounts of ports for various uses and needs, such as usb ports for upgradability and storage, HDMI/DisplayPort for graphical output, and various other ports that execute similar tasks mentioned in different variants. A speaker grill is provided that there is a speaker inside the case where it produces the requested sound by the user. 3 LED lights are provided in order to do maintenance on the computer, green meaning the system is functional, yellow meaning there is a faulty hardware issue (i.e. network problem, storage problem, etc.), red means there may be a power issue or a serious flaw with the hardware/software and isn't functioning as intended.
K4) 2-Button Design Interface	Two buttons are provided to help the user navigate through the applications much easier. While button 1 intends to navigate through apps one by one, button 2 is used to navigate through panel to panel.

	Each panel is similar to how smartphones have each panel that provides applications or widgets.

*A copy of the diagrams can be found in the appendices section

4.1 **Design Analysis**

The SCAMPER method was used to analyze and brainstorm each concept design. This method has helped to diverge the number of solutions and enhance the team's capabilities to explore collective thoughts and opinions.

Table 4: Brainstorming using SCAMPER Technique

Z1) The Spring Switch	**S:** Instead of a button, use a rotary dial that is operated with the users hand/wrist **A:** Can use laser actuator for the key switch to give force adjustability **M:** Make the button plate be able to change colours based on user visual choice or eye visibility **P:** Can turn the system on depending on if the wheelchair is pushing against it or not **E:** The foam on top of the pressure plate can be removed to save cost **R:** Rearrange the coil and switch to be between the soft material/cushion and the rigid material/bottom plate
Z2) The Function Slider	**S:** The slider can be a volume control instead of function set control **C:** Bluetooth speakers that can play mp3 files. **A:** The device is compatible with headphones for personal use **M:** A large rotary encoder (similar to ratio volume control button) can be used as a function set control **P:** The speaker can play music for entertainment **E:** The slide button can be taken away and the button will behave the same **R:** The slider button can be used to automate tasks and the press button can be used to switch between set of functions
Z3) The Light Switch	**S:** A stepper motor can be used instead of a servo motor **C:** Adding a light that turns on when the gear is turned upwards to turn the lights on, and fades away when it rolls back down

Gear and Rack	**A:** The same mechanism can be used with other devices (thermostat, TV) depending on the arrangement of the buttons.
Z4) Zee Web App Version	**S:** Instead of 1, 2, 3 clicks, having the a scanner button that detects which finger is used to press the button which would correspond to a specific function **C:** Add a speaker that voices the option selected **A:** Allow the caregiver/developer mode to be hidden from the main page (invisible to user/client) **P:** Add a function for entertainment: Games and Music
T1) Morse Code Design	**S:** Have separate buttons in both side of the chair instead of 2 buttons on the same side **C:** Make the speakers tell the user if they have typos and suggest corrections just like smartphones autocorrect **M:** Add a third button that has precomands that will execute with one click **P:** The morse code buttons can be connected to a screen and morse code games can be played **R:** The morse code buttons will call for help like other buttons if the user presses on either of them for more than 5 seconds
T2) Flip Phone Design	**S:** The screen can be detached and be connected to a keyboard or the wheelchair **C:** The computer can be built into the screen, similar to all in one PC's **A:** Sharing user data and needs via LAN to the caretakers wirelessly **M:** Supports custom made picture/drawings from caretakers that is specific to the user needs **P:** Can be used as a light day to day work computer, with video streaming capabilities **R:** Each application has a row of keys underneath it that is specific for the application used
T3) Interface	**S:** Icons can be instead of words to represent the 4 main pages of the user interface **C:** Combining the emergency feature with client's health monitor that would automatically detect and notify caregiver/emergency personnel **M:** Add a function where the user can use home appliances like the microwave or the fridge
K1) Wheelchair Mount	**S:** The button case can be mounted horizontally on the chair arm instead of vertically **C:** Velcro straps can be added for addition support **A:** The screen mount can be adjusted to place a book and read **M:** The screen l bracket mount can have more joints to allow more degrees of freedom

	P: Vertical and horizontal mounts can be extended from the screen support bracket and a try can be placed allowing the user to have a quick snack
K2) Graphical UI	**S:** The screen module can be substituted with a computer display, to be operated on the user computer **C:** Combine the user interface with a smartphone/ smart device like (iPhone, Apple watch) where notifications can appear on every device **R:** The reminders can be revered to narrated to the user instead of them scrolling through a list
K3) Computer/ Microcontroll er	**S:** Remote access computer which provides the computational power **C:** Can have an onboard screen to display hardware data such as data storage or the BIOS version and so on **A:** Support bone induction for sound output **M:** A microcontroller powered by a fast Qualcomm processor, LPDDR ram and nvme ssd for very fast and compact computer
K4) 2-Button Design Interface	**S:** Holding the button instead of pressing them to navigate through application or panels **A:** The buttons can be used to skip and control volume to listen to music **M:** Use a V shaped switch (similar to light switch) that performs two actions based on which direction the switch is lying flat on its cover panel

*Further Analysis is deemed to be unnecessary for the incomplete SCAMPER models due to high amount of redundancy

5 Concept analysis and evaluation

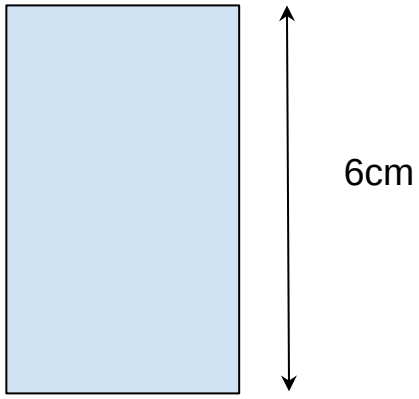
Each of the solutions were evaluated to satisfy the target specifications and client needs. The solutions were evaluated by pondering upon the following four questions:

- Can we make the idea work?
- Is technology available to implement the idea?
- Do we have time to develop the technology?
- Do ideas meet minimum customer requirements?

Table 1: Core Functionality Decomposition and Table 2: Solution Category and Associated Target Specification Number have references to the needs and metric numbers.

Table 5: Concept Analysis and Feasibility Study

Z1) The Spring Switch	This concept is feasible and can be easily implemented since all technology and equipment can be easily obtained from most electronics and hardware stores. This concept satisfies the button design category. The following equation is used to find the force required to activate the button $F = k(x_2 - x_1)$. In addition, springs with low compression forces can easily be found. The spring compression length and the distance between the switch and the rigid plate is used to find the distance traveled before activation. S - Does not satisfy the client need #8. A - Even though laser actuators satisfy the client's needs, they are not feasible as they are expensive. M - It is achievable and has a simple implementation route. P - It is not practical since it would require alternative power instead of the wheelchair, might require running in wall wiring. It also requires a complex system to trigger the system power. E - This idea will save on the costs; however, it will not pass the comfort user scale. R - This design is attainable since the coil's length can be shortened or halfed such that there is room for cushioning on the soft part of the button while requiring less force to travel as an actuator.
Z2) The Function Slider	Sliders with low activation activation force required can be implemented as an accessory to the button. Sliders technology is feasible, inexpensive and widely available. S - This idea is feasible, since microcontroller can be configured to control sound modules (ie. speakers) using the following library: `#include <AudioSound.h>`. If a raspberry pi is used it will also be feasible as it is equipped with an internal sound card that outputs sound to an audio jack. C - Bluetooth speakers' modules will satisfy metrics 2 and 4 as it will allow compatibility with a wider range of devices. In addition, the technology is feasible and inexpensive. A - This idea is feasible, if the sound produced metric is satisfied which entails having a sound with higher frequency than 60 dB. M - The rotary encoder is not an attainable design since it requires decent amount of dexterity which is not something the user can provide P - music mp3 files can be easily added to the Arduino library and raspberry code based on client preference at no additional cost. E - This idea is not feasible as it will reduce the number of metrics satisfied. R - This idea is feasible; it will depend on how the user wishes to interact with the device.

Z3) The light switch gear and rack	This idea is mechanically feasible the following gear calculations can be used to calculate the dimensions, teeth, pitch and mod of the gears  A spear gear with outer diameter of 2.75cm and 11 teeth is selected to fit in the 6cm distance, hence the following equation can be used to calculate the module of the gear $mod = \frac{Outer\ diameter(mm)}{\#\ of\ teeth} = \frac{27.5}{11} = 2$ The rack mod can be calculated as follows $mod = \frac{distance\ of\ one\ pitch}{\pi}$, hence the distance of one pitch is 1.25mm. S - It is feasible since stepper motor is only a bit more expensive than servo motor but instead provides more force and is more accurate C - This idea is feasible; however the wiring would be complicated to adjust since the device would be rotating. The battery life would also be an issue because the light would use quite an electric consumption. A - This idea is feasible, however the time constraint does come into effect here, because setting up multiple devices and doing modification would become too time-consuming.
Z4) zee web app version	This idea is feasible and some of its ideas will be used to create the user interface S - This idea is not feasible since the technology to implement it isn't possible yet. While there are fingerprint scanners, there is no way to detect which finger is being used to press the button without scanning one's fingerprint. A - This idea is feasible as it would satisfy the client's need for user friendliness.
T1) Morse Code Design	The morse code is feasible however it will require the user to have previous knowledge of morse code language. S - This idea will satisfy the user needs #10 and is feasible as it doesn't require additional technology C - The same explanation as in Z2C can be used to justify that feasibility of this

	idea M - This idea is will satisfy need#5 as it will increase the user friendliness of the device P- This idea will satisfy need #1 as it will allow the user to do more tasks with the device R - This idea is necessary to satisfy metric #13
T2) Flip Phone Design	This idea would not be feasible due to the high price associated with implementing a flip phone device S - The following will require separate processors for the screen and button. In addition, the time required to implement it might exceed the time we have for this class C - This idea requires expensive technology A - This idea is feasible by using any cloud-based storage with GB 16 to satisfy need #21 M - This idea is feasible but will require a good quality of pictures that would satisfy metric #6. R - This idea would be unfeasible during to its complexity and high price
T3) Interface	This idea is feasible; however, it would mostly depend on the user's preference on how they would like the user interface to look since they would be interacting with it on a day-to-day basis. S - This idea is feasible; it would simply require designing icons to represent each part of the user interface. C - This idea is not feasible since the user must already have a constant health monitor and it would be quite expensive to link the device to their monitor. M - This idea is not feasible as it would be very expensive since it requires the appliance that links with the device to be a smart device.
K1) Wheelchair Mount	This idea is feasible, since it satisfies the client's needs of mounting the device on the wheelchair. S - While horizontal layout for buttons is typically the way to go, for the specific user in mind such layout would be difficult to use, so in this specific case it's not advantageous C - Velcro's are easy to adjust, are affordable and provide decent source of support, thus it can be considered feasible A- It is feasible to implement a book holder/document holder near the computer screen, but the implementation need is dependent on the user M - It is possible to add more joints to have more movement and flexibility regarding the mount and the computer attachments P - While it would provide the user a lot more space to station stuff on, it would limit probable future advancement for the design in terms of space and also it may become too crowded for the user to the point of discomfort, not beneficial

K2) Graphical UI	This idea is feasible, it would simply depend on how the user prefers the user interface to appear. S - It would be cost beneficial but since the screen may vary and is meant for a PC, it might not be appropriate for the use on the wheelchair, thus not feasible C - It isn't applicable since it would require the user to have a smartphone or a smart electric device to be able to access these notifications R - It is feasible, since the point of the design is to assist the user
K3) Computer/ microcontr oller	It is feasible since it provides the essentials performance of a basic computing unit. The computer provides I/O ports for future extensions, speakers within the device case which are needed for the user purpose, and a computer health status indicator with lights for easy maintenance. S - It could be applicable, given that a cloud based VM provider has services at a low-cost rate C - While it would be a great feature to have displayed the status of the machine on itself, it is an expensive method to do so and thus its not practical A - It is a useful feature since it will help with people who have hearing troubles, but even so since the technology is kind of new, it is too expensive for our scope and thus not feasible M - This would provide great performance similar to an Intel NUC and maybe even at a cheaper price too but for the purpose of the project, it is overpriced and provides more performance than required which is unnecessary, so its not suitable
K4) 2- button design interface	This idea is not feasible since the target user is only able to operate a single button and so two buttons would make the situation for the user difficult. S - This idea is not feasible with users with high dexterity A - This idea is feasible with Arduino and raspberry pi and can be implemented using #include <AudioSound.h> or python libraries for the raspberry pi M - This idea is unfeasible as it requires a switch that not all users might have

5.1 **Decision Matrix**

The weight of each design criteria is obtained from the value of importance found in table1. Each feasible sub concept (ex K4S) is added to the main concept (K4) and evaluated as a whole concept in the decision matrix. as a collective the team scored each design with respect to the design criteria found in table 1.

Design Criteria	Weight	Z1	Z2	Z3	Z4	T1	T2	T3	K1	K2	K3	K4
Automate simple daily tasks *	7%	0	3	1	3	0	3	5	0	4	0	2
Includes a simple dialogue commands	8%	0	3	0	2	3	2	4	0	4	0	0
Can produce sounds of multiple simple phrases	8%	0	3	0	2	4	3	0	0	0	3	0
Can access home devices e.g. TV, thermostat	5%	0	0	0	0	0	1	0	0	4	0	0
Can connect to Wi-Fi	5%	0	0	1	0	0	1	0	0	3	3	0
Features can be customized by a separate user interface	8%	0	3	3	3	3	1	5	2	0	1	2
Includes Images/figures representing words/requests	3%	0	0	0	4	2	4	5	0	4	0	0
Buttons require very low effort to use	8%	4	0	0	0	3	2	0	0	0	0	3
Buttons are large and separated	8%	4	3	0	0	3	1	0	0	0	0	3
Is resilient against physical damage from indoor and outdoor factors	2%	2	2	1	0	2	2	2	4	0	3	2
Supports different languages	2%	0	1	0	1	1	1	1	0	2	0	0
Has an emergency contact feature	2%	0	1	0	0	0	0	4	0	3	0	0
Is modular and can be upgraded down the line	6%	0	3	0	2	2	4	4	4	3	4	1
Is mountable on a wheelchair	5%	0	1	0	0	0	0	0	5	0	3	2

Can be installed either side of a wheelchair	5%	3	1	0	0	0	0	0	3	0	2	2
Surfaces are smooth and comfortable for the palm of the hand	4%	3	1	0	0	3	5	0	2	0	0	3
Uses wheelchair power to operate	4%	4	4	0	0	2	2	0	3	0	3	2
Is cost efficient/ inexpensive	10%	3	4	2	4	1	1	5	3	3	3	2
sum	100%	1.41	2.13	0.58	1.43	1.82	1.83	2.1	1.38	1.65	1.44	1.48

The color code in the decision matrix corresponds to the following:

Table 6: Decision Matrix Color Code

Solution criteria	Decision Matrix Color Code
Electrical Communication	
User Interface	
Button Design and Mount	
Other Solutions	

With the decision made, the following 4 designs were selected based on the design evaluation, criticism, weight, and score:

Z2) The function Slider

T3) Interface

K1) Wheelchair Mount

K3) Computer/ microcontroller

6 Final Group Design Concept

The chosen solutions were refined, and a description of the sub solution is provided in the following section.

Electrical Communication

The Raspberry Pi will have an display output via HDMI, which can connect to a display as one of its main functionalities. To be able to use the buttons that have a 3.5 mm mono port, a 3.5 mm jack to USB-A adapter can be used to plug it to the Pi. A mono speaker, with a minimum of 5W power delivery, will also be paired along with the Pi that can produce high intensity sound so it can be heard indoors and outdoors. For easy access in regard to the OS, the Raspberry Pi provides an SD card slot which is where it's OS is stored (granted there is an SD inserted) and so if anything such as pictures, names, or applications need to be updated or modified by the developer in the future, it is very much so possible. The Pi will have a Wi-Fi adapter, which via TCP/IP it can communicate with wireless devices on the LAN, this would refer to smart home devices and switches.

User Interface

In terms of the software component of the device, the concept that was the best for the user interface was T3, while obtaining some ideas from both Z4 and K2. The user interface will be separated into 4 categories: Home devices, simple phrases, emergency, and custom. The categories will be represented visually by icons. The home devices section will be able to connect to a smart TV, a smart home device like Alexa and turn and close the lights. The simple phrases section will contain a list of phrases the user can sound out through the speaker with the help of the button. This section contains the phrases that the user uses on a daily basis. The emergency section allows

the user to indicate if they need assistance or medical attention that is not life threatening. When the emergency function is used, the speaker will sound an alarm to get the caregiver's attention. The custom section allows the caregiver to modify the simple phrases section to add or remove the list of phrases depending on the user's daily activities. The custom section also allows the developer to add more functions to the devices as a whole. The whole interface and functions will be coded using Python 3.6.

Button Design and Mount

Based on the decision matrix the winning concepts for the button design and capabilities are Z2 and K3, as well as some concepts taken from Z1 and K1. The button activation surface will have the following dimensions 6 x 8 cm^2. The button will use a raspberry pi as its operating system to communicate easier with other devices. For charging and compatibility of other devices, it will have a mono port, I/O port, and a USB 3.0 port (K3). In addition, the device case will have a speaker grid and a light indicator. The spring mechanism discussed in Z1 (with variation Z1M) will be used to build the button. Z2 with variation Z2S, Z2A, and Z2P will be used. The button mount used in K1 will be implemented in addition to K1C.

7 Visual Representation

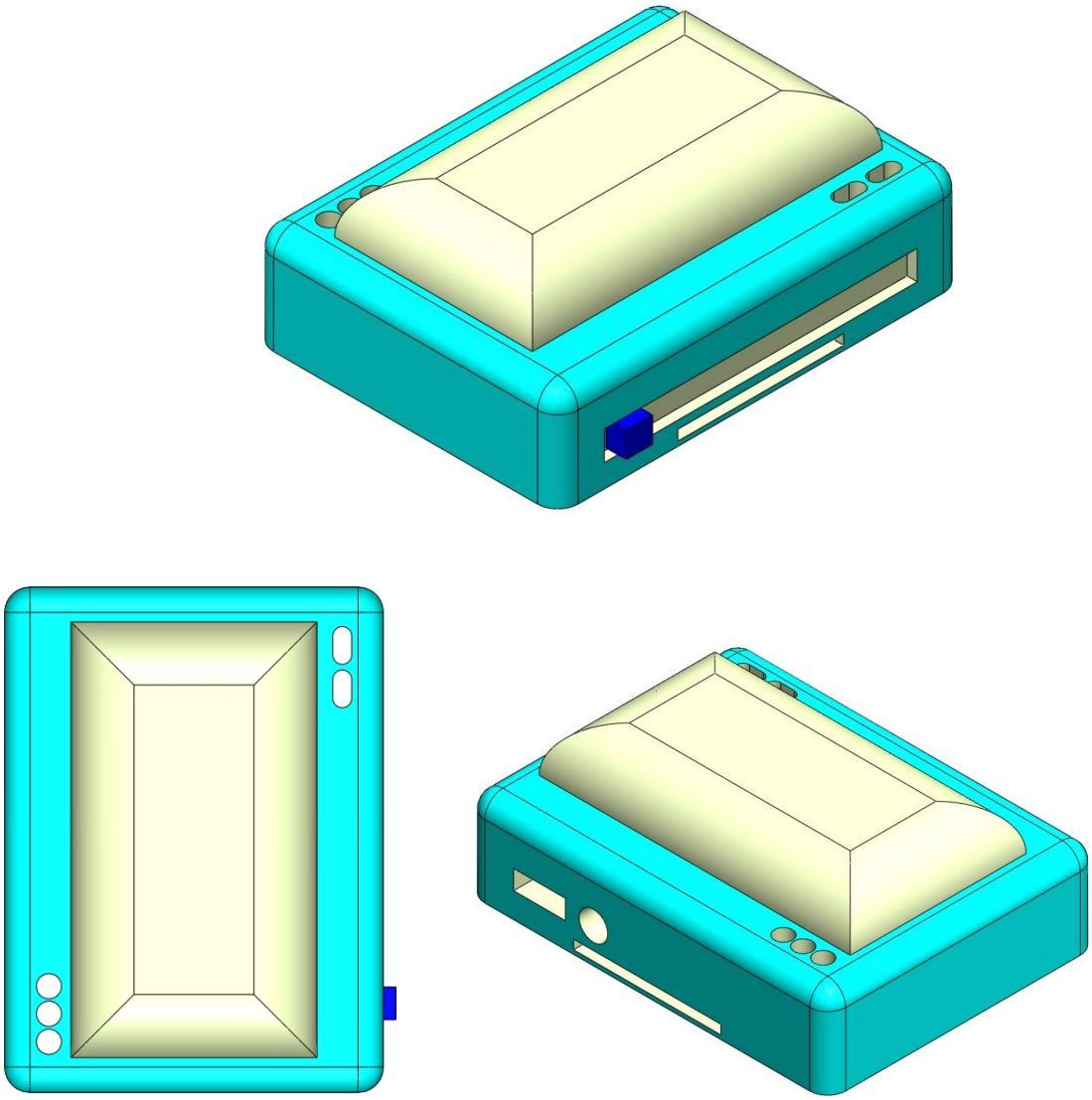


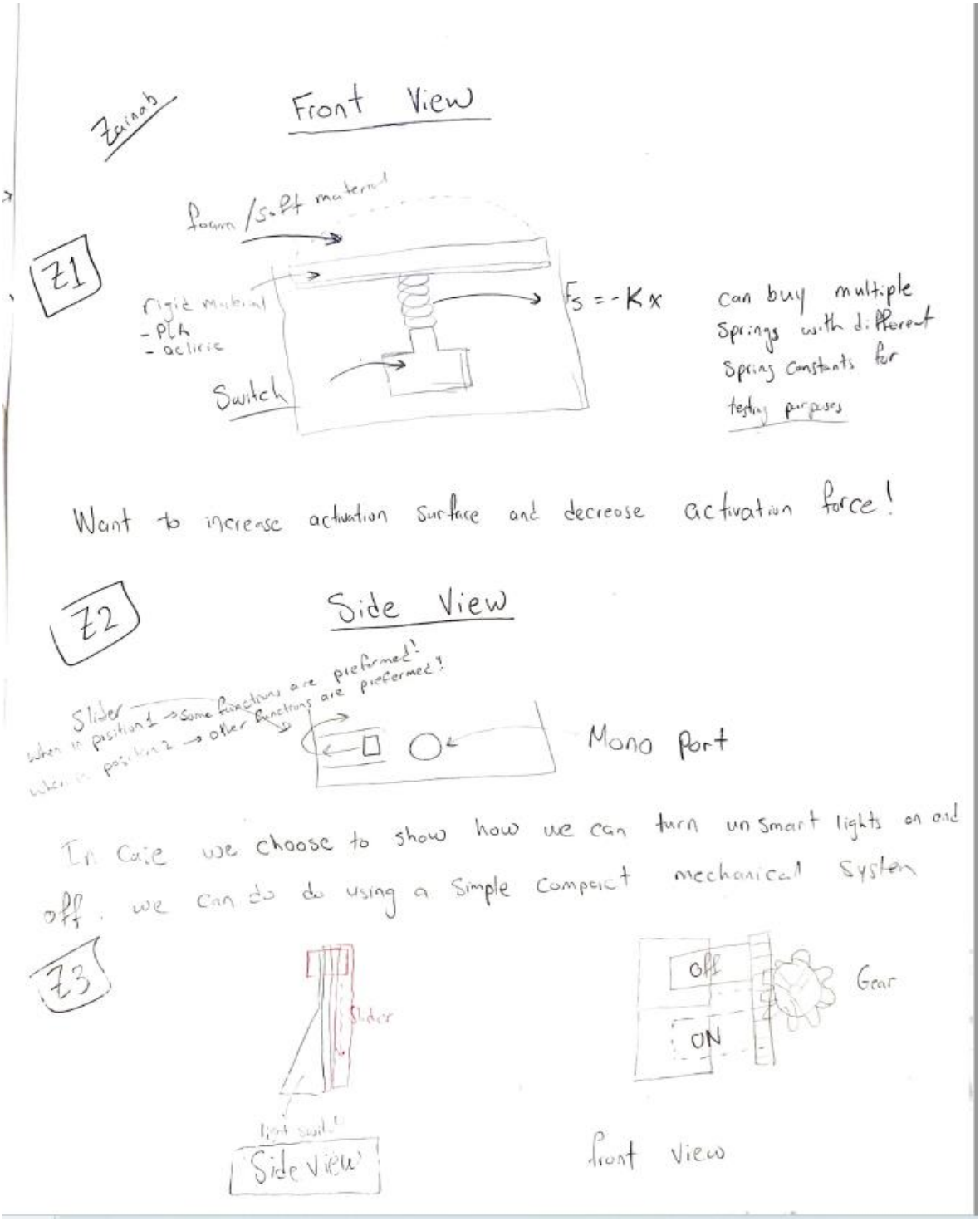
Figure 3: Physical Representation of Button Case and Mount

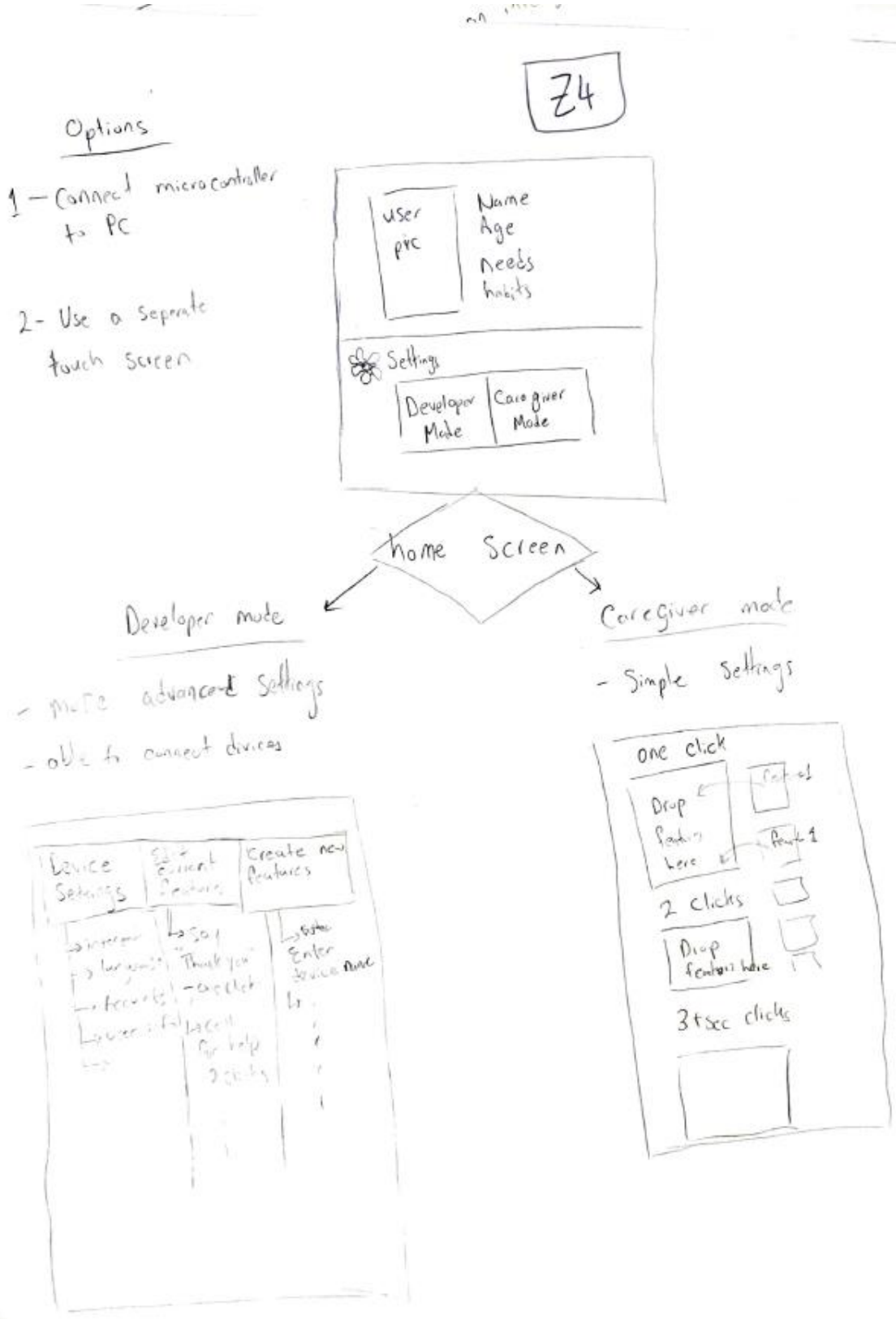
8 Conclusions and Recommendations for Future Work

The final design idea was put together by benchmarking the ideas of the group and coming up with a final design that accommodates everyone's ideas that are relevant and important to the needs of the Talk Box project. While the scope of the groups design is to accommodate the user with as much as verbal assistance as possible, due to budget and time constraints, while containing key aspects, may not achieve exact target specifications; as of right now, modularity is a bit limited in the design due the reasons mentioned, this would mean limited I/O ports, storage, application development and so forth, however the core model has been thought out in such way that it is possible to improve upon the idea and enhance it down the line, where it doesn't all necessarily get limited by hardware. Our benchmarking was done to accommodate a single user in order to meet specific design criteria, but the goal of the group is to get the software and hardware to be as flexible as possible so that the core function of the design doesn't disappear. Raspberry Pi was selected to be the main hardware component with custom designed and printed buttons which require low physical effort to use, along with the software which will be done in Python, since it offers the most flexibility for implementing our ideas.

APPENDICES

APPENDIX I:

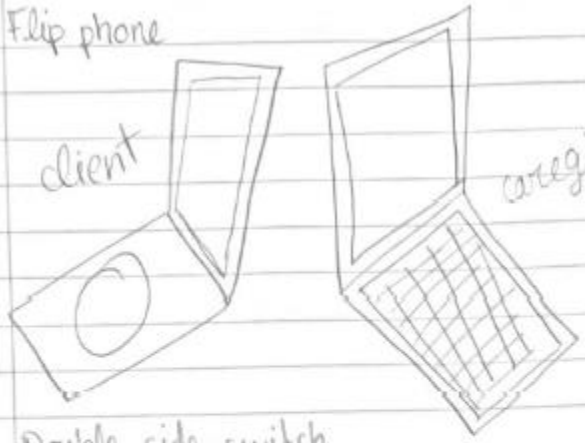



Z4
Options
1 – Connect microcontroller to PC
2- Use a separate touch screen
user pic
Name
Age
needs
habits
Settings
Developer Mode
Caregiver Mode
Home Screen
Developer mode
- more advanced settings
- able to connect devices
Caregiver mode
- Simple settings
Device Settings
Create new features
one click
Drop feature here
2 clicks
Drop feature here
3+sec clicks

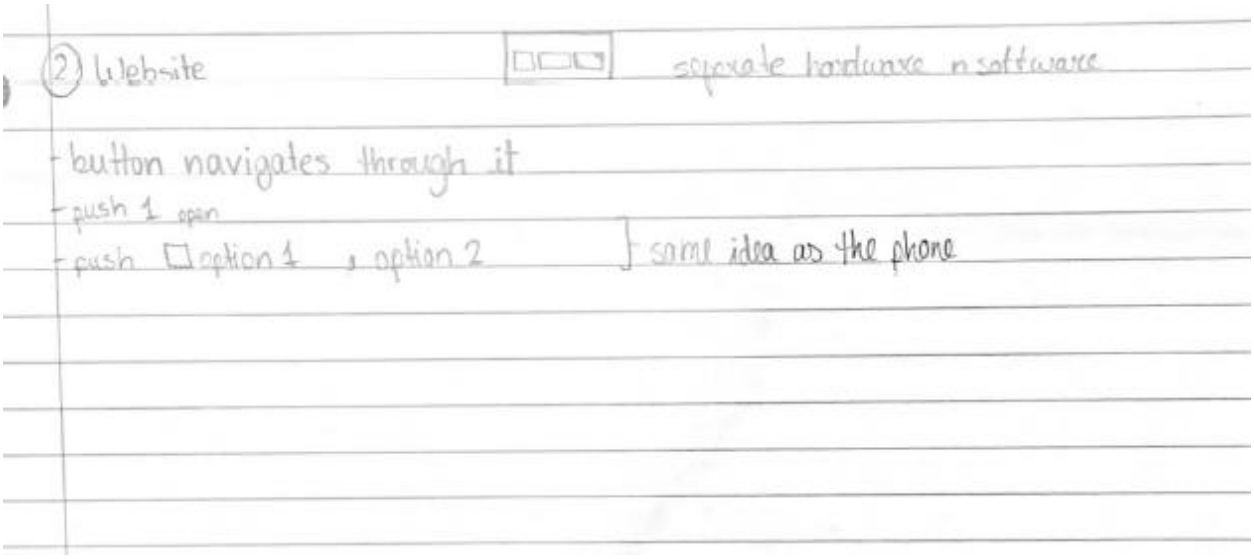
① morse code

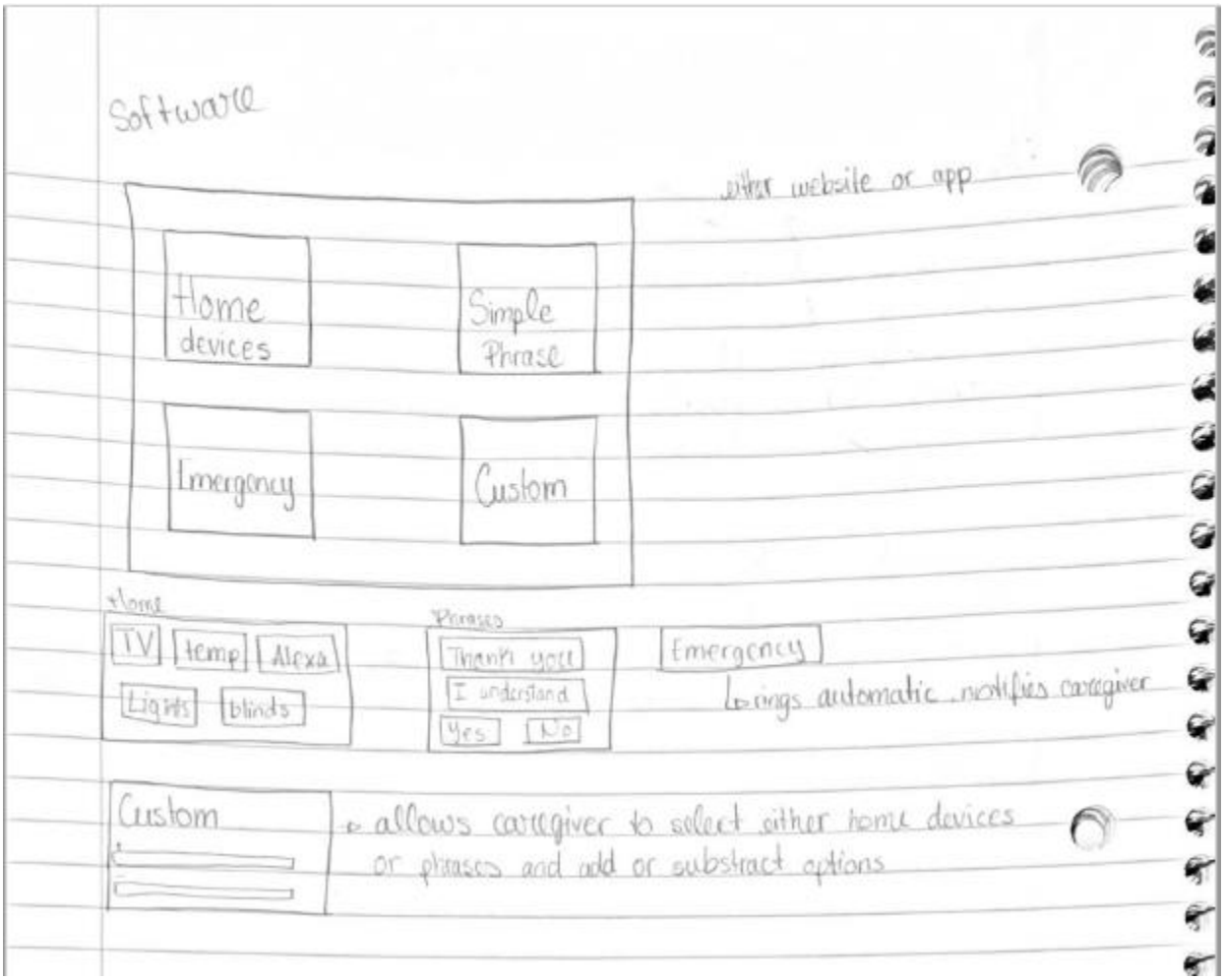
- 2 buttons
- assign only one for on
- assign only one for off
- allow to type out whatever they want to say
- if they type tv or temp or Alexa it goes where

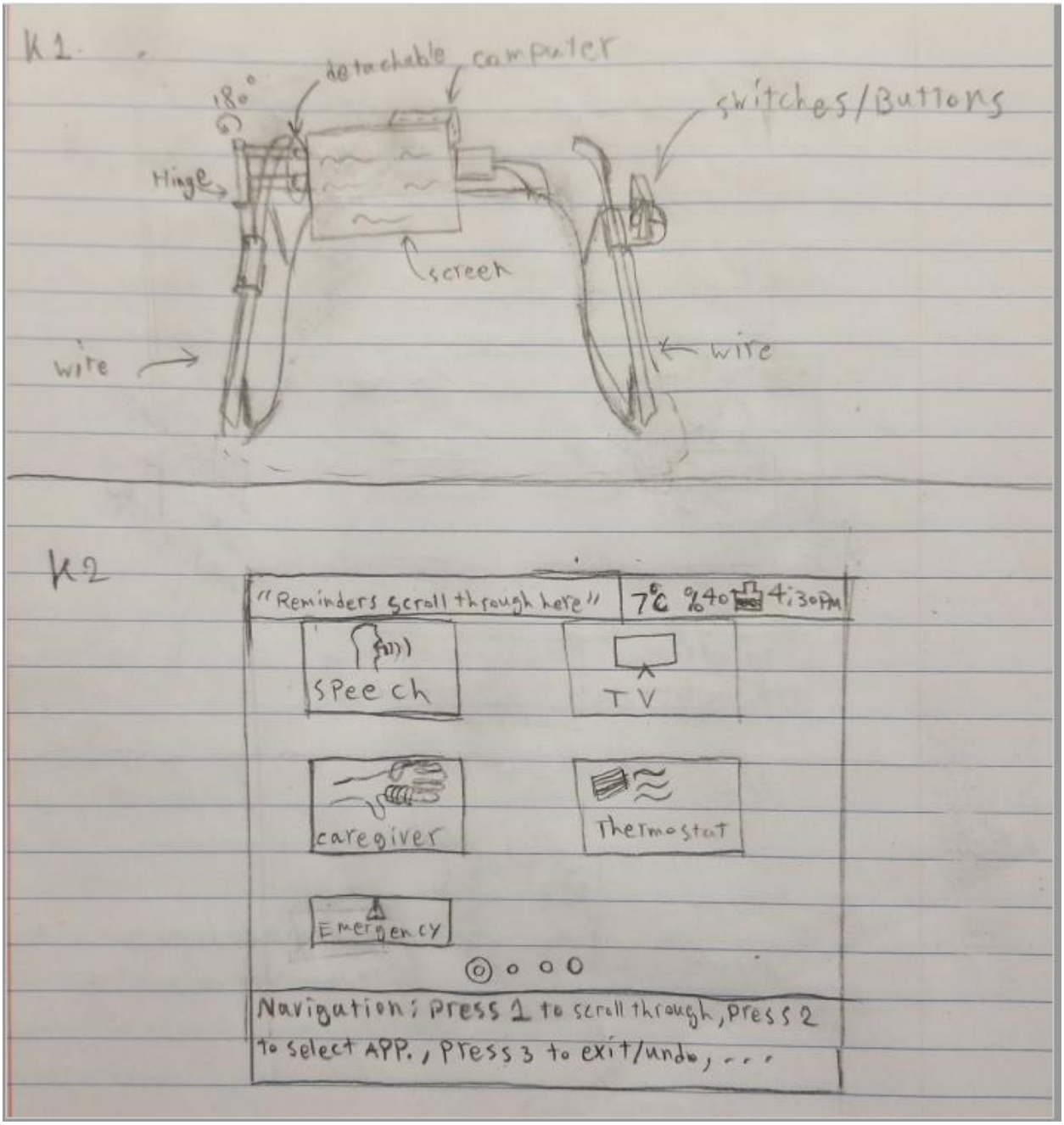
Flip phone



Double side-switch
- same concept as my computer
- when you flip it works as touchscreen for caregiver
- when you flip again it works for client with one smart button with a screen
- laptop size


(2) Website
separate hardware n software
- button navigates through it
- push 1 open
- push ☐ option 1 , option 2
same idea as the phone


Software
other website or app
Home devices
Simple Phrase
Emergency
Custom
Home
TV
temp
Alexa
Lights
blinds
Phrases
Thank you
I understand
Yes
No
Emergency
brings automatic notifies caregiver
Custom
allows caregiver to select either home devices or phrases and add or substract options


K1
detachable computer
180°
switches/Buttons
Hinge
screen
wire
wire
K2
"Reminders scroll through here"
7°C %40 4:30PM
Speech
TV
caregiver
Thermostat
Emergency
Navigation; press 1 to scroll through, press 2 to select APP., press 3 to exit/undo, ...

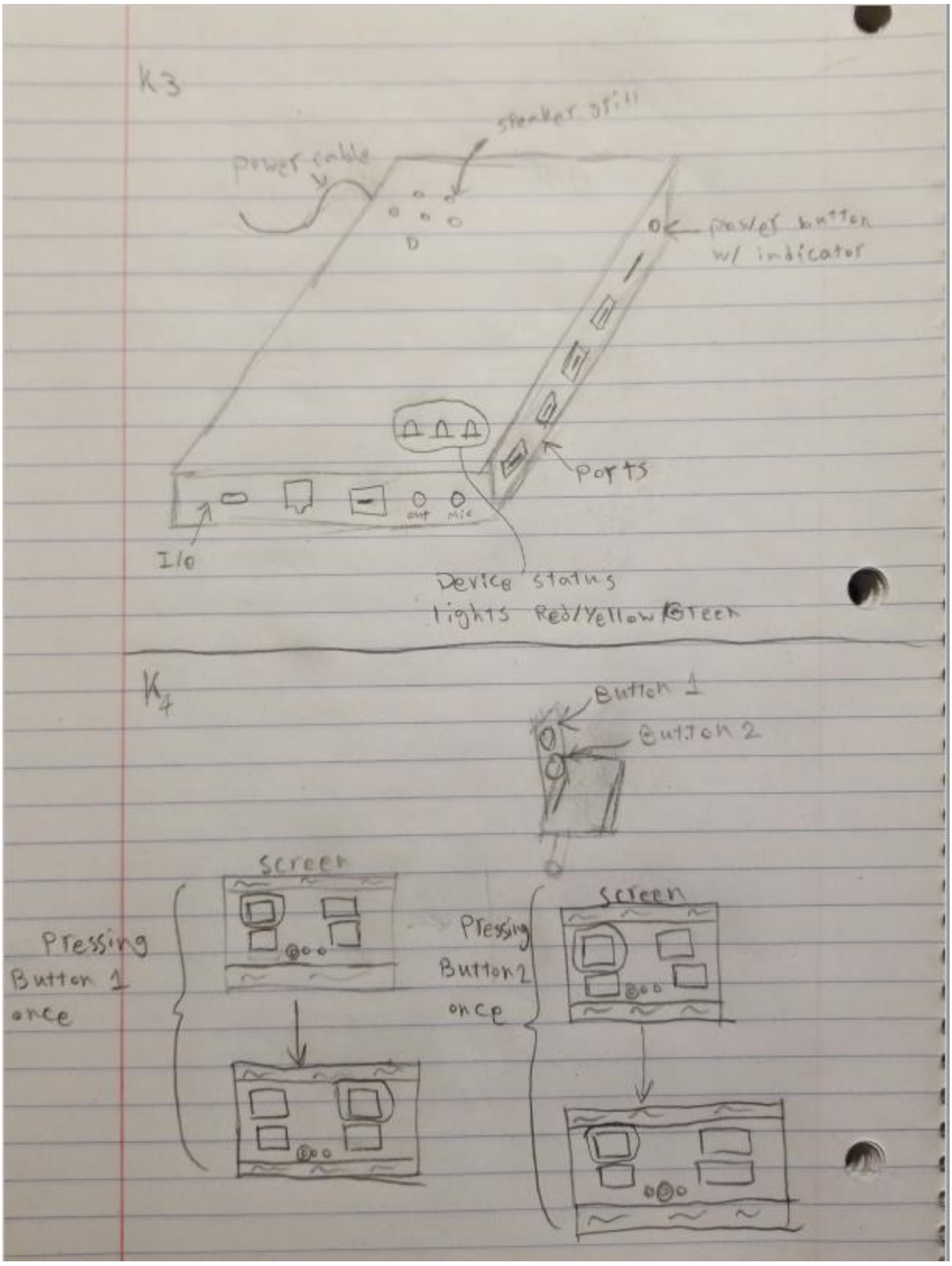

K3
speaker drill
power cable
power button
w/ indicator
ports
I/o
Device status
lights Red/Yellow/Green
K4
Button 1
Button 2
screen
Pressing
Button 1
once
screen
Pressing
Button 2
once

Table 7: Target Specifications

#	Metric	Unit	Value	Solution category
1	Button response time	Processing time	Fast	Microcontroller
2	Capability of simple dialogue commands	Processing time	N/A	Microcontroller and speaker module
3	Sound produced	dB	>60	Microcontrollerand speaker module
4	Connection to Home devices (TV, thermostat, Wi-Fi)	# of devices	>1	Microcontroller
5	User friendliness	Usability	3	user interface
6	Quality of images displayed	PPI	~146	user interface and screen used
7	Force required to push button	N	>4	button design
8	Travel Before Activation	cm	N/A	button design
9	Size of button(s)	cm^2	~6.5	button design

10	Space between button(s)	cm	N/A	button mount
11	Operating temperature	Degrees C	15-30	Microcontroller
12	Languages supported	# of languages	1-2	user interface
13	Emergency procedure	Binary	Yes	user interface
14	Features offered	# of functionalities	3	user interface
15	Ability to mount on either side of wheelchair	Wire length (cm)	N/A	button mount
16	Device comfort	Comfort scale	N/A	button mount and button design
17	Electric Consumption	W	2-5	Microcontroller
18	Maximum cost	Cad $	>=100	All categories
19	Screen Size	cm	~38	Microcontroller modules
20	Weight	gram	<2000	button mount and button design
21	Data Storage	GB	16	Microcontroller