University of California, Santa Cruz

TRAVIS
(Television Remote and Voice Interpretation System)
Simplified remote control with voice recognition

Ann Sophie Abrahamsson, Nathan Banner, Lillian Gwendolyn, Katy Johnson,
Aidan Martens, Heath Robinson, Kanybek Tashtankulov
Group 9
CSE 123A/B
David Harrison

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Executive Summary:

The purpose of the TRAVIS Project is to build a simple and universal television remote control. Modern day TV controllers have many buttons that are tiny and hard to press for people with limited mobility or sight. The TRAVIS Project aims to solve this problem by producing a voice-enabled TV remote with the bare minimum number of large. easy-to-press buttons. This goal is illustrated with the acronym, TRAVIS, that stands for Television Remote and Voice Interpretation System.

TRAVIS is intended to help out the elderly, the disabled, and any family or caretakers of theirs. This product is intended to be a quick solution for a number of problems related to browsing modern entertainment devices, including incorrect button inputs and difficulty with seeing the screen and remote. TRAVIS will be a low-cost product that is simple to set up, long-lasting, and, most importantly, accessible because of its reliable voice-control accuracy - with TRAVIS, instead of searching for specific buttons you can just ask 'Hey TRAVIS, can you play Wheel of Fortune', or 'Hey TRAVIS, where did I leave the remote?'

This document includes our design objectives, with voice recognition accuracy and sustainability being key factors in our design. Similarly, this document contains all of our conceptualization, including our brainstorming, 6-3-5 method, mind-mapping, and morphological chart. Conceptualization activities helped us narrow down our ideas into a decision table, with three options for a final design: a remote control, a box that plugs directly into the TV, and an app that acts like a TV remote control. The decision table output helped us decide that the remote control was the best fit for our project goals.

Also included in this document is our design for manufacture and assembly, with details of TRAVIS' button and hardware layout, and the construction of the prototype shell. Alongside the DFM is the budget for the design as well as a drawing detailing the analysis of the critical paths needed to complete our project on time.

TRAVIS will only take audio input when its button is toggled on in order to avoid possible breaches of consumer privacy. While we have no plans to record and sell people's data, it would give the consumers peace of mind to know they are not being recorded.

Currently, we are finalizing our outward facing design and beginning to work on our internal codebase. While this is currently progressing smoothly, we do expect to encounter some resistance once we truly begin working on audio-processing. We hope that the open-source libraries we use will be advanced enough to limit audio interference and provide clear responses, as well as accurately send TV IR signals to change channels and so on.

Ethics Statement:

We, in the fulfillment of our professional duties, shall:

1. Hold paramount the safety, health, and welfare of the public.
2. Perform services only in areas of our competence.
3. Issue public statements only in an objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.
6. Conduct ourselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.
7. Create products that are sustainable and do not negatively impact the environment.
8. Maintain the privacy of our customers and will not use any voice recordings for malicious purposes, nor share or sell it to third parties.

Source: https://www.nspe.org/resources/ethics/code-ethics for 1-6

Personas:

Persona 1:
Name: Edith

https://depositphotos.com/vector-images/old-lady-cartoon.html
Role: Elderly person with visual impairment
Background:

- 80 year old woman who lives alone, has one daughter who visits twice a week to check on her
- She has macular degeneration and is therefore visually impaired
- Watches television everyday but has trouble navigating channels because she isn't able to see buttons on remote clearly.
- Calls daughter whenever she has technical problems

Goals/Behaviors:

- Wants to operate remote without needing assistance

Persona 2:

Name: Susan

https://www.istockphoto.com/illustrations/older-business-woman

Role: Part-time caretaker of her elderly mother

Background:

- Works full-time at a business firm
- Visits mother twice a week when she has time, makes sure she is taking medication and fixes television problems

Goals/Behaviors:

- Wants mother to be able to use television independently
- Reduce amount of times mother calls her during her busy day to fix television problems

Persona 3:

Name: George

https://stardewvalleywiki.com/George

Role: Elderly person with a movement disability

Background:

- Wheelchair-bound after workplace injury
- Doesn't like relying on others' help
- Likes watching TV

Goals/Behaviors:

- Wants to watch TV without needing assistance
- Wants to be able to set up device without help

Need Statement:
Elderly people have a hard time navigating modern entertainment devices.

Goal Statement:
Make it easier for elderly people to navigate modern entertainment devices. Product will be at least 50% recyclable.

Design Objectives in Words: Design a remote with a short setup time and accurate voice command response that quickly and accurately changes channels for the user. The remote should be inexpensive to manufacture, have a long battery life, moderate charge time, and large buttons for ease of use.

Design Objectives:

Design Objective	Units	Target/Range
Short setup time	minutes (alexa setup as example)	< 10
Short time needed to change channels	seconds	< 20
Inexpensive to manufacture	dollars	< 10
Device Uptime	hours	> 20
Task Startup	seconds	< 5
Voice Recognition Accuracy	Percentage	>60%
Damage Likelihood (External)	Percentage	<10%
Average Lifetime (Internal)	Years	>2
% Recyclable/Biodegradable Material	Percentage	>50%

Brainstorming:

- 3 design ideas: remote control, phone app, or box that plugs directly into TV
- Remote control:
    - Have box that receives signal, use remote to communicate with
    - Large buttons, easy to press
    - "Find remote" command lights up remote, possibly vibrates, makes chirping sound until button is pressed or command "Okay remote, I found it" is given
- Voice-activated, give voice commands to change channels, lower volume, increase volume, turn on/off, source, mute
- AI is called TRAVIS (Television Remote and Voice Interpretation System)
- Initiate voice commands with "Hey Travis"
- LED lights up when voice command is being processed, turns off when done
- Needs detailed set of instructions to make setup easy
- May not need to require internet, bluetooth connection?
- Simple to charge, charging stand, possibly wireless charging
- Different language settings
- Makes sound when voice command is initiated
- Have button to press to initiate voice command so remote isn't always listening
- Option to preset channels
- Be able to find specific channel for user, like if they say "Hey remote, put on Discovery Channel"
- Type in channel numbers for user
- For specific program, like "The Amazing Dr.Pol", tell user what time the program is on and what channel
    - Ask the follow up question "Would you like to go to this channel?"
- High contrast color palette for remote, black remote white buttons, white remote black buttons; yellow remote black buttons, black remote yellow buttons

6-3-5 Method:

Idea 1	Idea 2	Idea 3
have a button on remote that can be pushed to locate it	charging stand for remote	App displays remote's current location and charge
Maybe a button that is separate from the remote to locate the remote. For example have the button integrated into the couch or wheelchair if they have one. Also have the button cause the remote to make a sound when it is pushed.	Make the charging stand a plate instead. Could be a large charging plate so that it is easy for people who cannot see well, to simply put it down without having to get it into an exact charging position. Maybe could even make like a little sidetable where the whole top of the able can charge the remote just by sitting on it.	Maybe have a camera embedded in the remote so when using the app and trying to find its location you can turn on its camera to see what the remote is seeing.
Bluetooth-connected trackers to locate devices embedded into remote, possibly some haptic feedback for those who can't hear well and see well, maybe the remote vibrates more as you get closer to it (Marco Polo remote)	Magnetic charging stand, would help if remote has a rubber casing so you could just toss it or place it on any part of the surface so it latches on	possibly a 360 fisheye camera? in case the camera side is facing down
Make it have a function where you can ask the remote where it is vocally And it'll respond if it hears you	A wireless and wired charging option like smartphones have	Have a tiny pinhole camera that cam see its surroundings?
yeah maybe like a wall mounted thing so you can put it next to your lightswitch so that whenever you hit it the remote beeps and vibrates and whatnot	probably just wireless or swap the batteries, maybe two different versions cause rechargeable batteries are hard to find anyways wireless charging is probably simpler to understand if u give it like a charging indicator or something	maybe give each remote a code so that the setup isnt wierd and you can just attach it to any unattached remote probably a security risk idk
Could give the remote a phone number that will buzz/ring the remote when you call it, so no extra devices needed.	Charging stand could have the button to locate remote since it'll probably be in one place mostly.	could use the camera for face recognition so it knows who's using it and can have personalized settings, probably pretty hard to actually do though

Idea 1	Idea 2
Box sends IR signals directly to tv from like 6 inches away so no lag or missed inputs. Could be connected to with a remote or app or just voice controlled.	Any of our ideas could search through a channel guide from the internet to find what's playing at what time, and if someone wants to watch something not on at the moment it could let them know when it would be on. Could maybe find some natural language processing to match what's said with show titles instead of basically speech to text and ctrl-f.This might've been said already but I can't remember.
use bluetooth connection instead of infrared. doesn't rely on direct line of site with the box or short distance	could have a "favorites" list for the user that tells them when their favorite show is on and on what channel; would need some way to periodically check channels and a display; could alternativey store the info and then have the voice command "hey TRAVIS, when are my shows on today?"
Bluetooth sounds good, other than that maybe put something in place so that not just anyone can tamper with the tv and change the channels.	Could also add a capability to remind users when a show is about to start. So you tell the box to tell you when this program is about to begin and then the box rings an alarm out to you or just speaks out "hey your show is about to start in 5 minutes, would you like me to put it on the tv?
Avoid tampering by having voice authentication, have them repeat vowels and consonants so it can recognize their mannerisms, finger print sensor on physical remote	have this work with multiple devices set around the house, or combine it with a wristband so the user knows if the show will start if they are not within tv proximity at the moment
Implement profiles for different people that use the remote	Could ave something like speeddial for channels the person really enjoys? Easily configurable
security setting probably isnt needed as old people would probably enjoy pranking people and like, its a tv who would mess with it	yeah like if we have a remote we can just put it on a button to go to whatever channel the favourite one is on, same goes for app

Idea 1	Idea 2	Idea 3
TV Bar like the ones that attach for things like a wii	tv remote but you can point it at things and click on them + being able to use it like a normal remote	alexa/google/whatever voice box integration so like a module that attaches to it that lets it send tv signals but otherwise just uses its normal voice recognition capabilities
Use for gesture controls and a pointer? Coudl also build in some sport and party games lol	Oh this is pretty much what I said in the last column oops. Idk what else to add but this could make the controls more intuitive than a standard remote.	This would be cool, voice assistants usually have good smart home/external device control I think. If we were to do this we might be able to take advantage of the advanced language processing capabilities these companies have too. Could also probably connect with the users phone as well since that's usually linked with a hardware assistant.
have certain dances connected to turning switching to a preset channel, way for a senior to get a little bit of exercise; ex) the macarena means switch to Disney Channel	bruh. basically a wii remote, would needd to include calibration, have simple calibration mini game where you connect the dots to draw a picture?	if we use a google home we could use its voice recognition features potentially, not sure how that would work though but it would be the interface for communicating with the TV.
maybe also every hour or so it tells you to get up and do a little movement before it lets you continue watching.	idk what else to add sorry	maybe use it for more than just the tv, and have it be able to control multiple things in your home.
Group exercises for people in retirement homes watching TV, or for friends watching the same show at different locations, more incentive to move about if against ur pals?	uhhhhhh, so a Bluetooth controlled remote instead of IR? Idk an app works better idk how to specify this either	Improving upon the smart plug application. this exists with limitrd capabilities like turning on/off, on duration. could make it more applicable
Could allow for setting timers to automatically turn off the TV or something? Like how some radios have sleep timers	Add a smaller screen for you to use certain functionality with? At this point now it's a Wii U	Can control any smart devices in your house, including the television, light bulbs, locks, etc. This would fit best as an app or something

Idea 1	Idea 2	Idea 3
A television addon similar to a Roku box where it adds extra voice-recognition functionality rather than replacing what the TV already has.	An app similar to the Apple Remote app which, instead of being button based, would be voice-controlled.	Something that goes on your wrist??
Check if Roku lets you develop apps to work on it, maybe be able to work with already existing stuff and just hook up a microphone to it	See if we can find apple remote source code or a binary of it and just add voice functionality and have it translate into apple remote commands	maybe we can add those like wiimote straps to it like how old people have their glasses attached to their ears with a string so the remote gets lost less?
I think Roku remotes already have a microphone iirc. I think it's mostly only for entering text though so definitely room to add functionality like commands.	Might be easier to interface with than old fashioned tvs and channels	Maybe also have it able to tether to like a table or couch so it doesn't get lost
could use the text entering function to enter in shows on netflix/hulu/whatever, text entering could also be used to "manually" type a channel number on the TV	Keep in mind that some older people don't have smart TVs/ don't feel comfortable or are scared of using them. Would user need to be savvy or can someone set it up for them once and then they can operate it wj/o help?	have a clip(like a book light clip) w/ a tether for the remote, needs to be somewhat sturdy
idk what else to add, idk what roku is sorry.	Could try to make this without needing internet, just have all the functionality right inside the box.	make it comfortable so that it does not hurt after a while, also could make it a simple necklace that you can speak into that is directly connected to the tv, you would only take it off during bed on the nightstand to charge.
This exists, roku does let 3rd party apps develop for it, base roku remote is basic, idk all these ideas are remotes y'all lmao, roku attachments for ergonomics since the roku infrastructure is already decent	No internet is very limiting, makes it harder to update later on too. Idk why not include eye tracking instead, much more reliable, or combine the two for better accuracy	Have labels for easier identification, maybe braille on them too

Idea 1	Idea 2	Idea 3
App to detect public facilities (bathroom, water fountain etc)	Electronic posture checker	Ergonomic phone cases (idk lol)
Built in map which shows where the nearest restrooms are? Could come in handy at amusement parks, malls, etc.	An app that detects your posture using some kind of outside electronic device on your back or something? I could use one of these lol	A phone case that melds to the shape of your hand in order to maximize comfort? Does that really need electronics tho or can it just be memory foam? lol
could make a service that will go to places for companies and walk around and mark things on google maps for them at like a cost or something	can see if we can just make one of those posture holding things with a bit of slack in them and one of those checkers so it holds you a bit but also makes sure you know when you're slacking and stuff	phone case combined stress ball and stim toy so you can like squeeze it when stressed and otherwise play with it like those silly putty things or those like goo balls that expand between ur fingers when u squeeze them
automate it somehow? Or some way to add a bunch of tags at once for places that are expanding quickly. It would be cool to see smaller but importand things on google maps but idk the process for adding stuff.	could track your posture throughout the day like a fitness or sleep tracker and let you know trends about your posture	case with slots for multiple types of tactile things to suit people's preferences
app that user can use to make a detailed map of a building or amusement park, could be large or small scale, map can be shared and if the map includes restaurants then the user can pull up yelp reviews	user can set a goal for how they want their posture to be, keeps track of whether posture is consistently at goal posture, if not gives tips on how to improve posture and possibly other health tips	compartments on phone case that have a latch, can be popped open or close, see through
could also add capabilities for the user to add a suggestion, if they found somehting not already on the map.	Could have something that tells you at what time of the day your posture is the worst or what activity you were doing during that time.	something that would be personal to you so that only you know how to open and close the compartments.

Idea 1	Idea 2	Idea 3
Make everything built into the remote so that no internet is required. The current generation of old people did not grow up with internet and are too old to try to understand how to use computers or smartphones.	Add functionality to call people from their landline by using asking the remote to call them. Since some of the elderly have a hard time seeing, they can't type in a phone number so having a set of saved numbers and telling the remote to call could be cool. so basically it connects to the tv and the landline?	Add a functionality to video call, if internet capability is there.
Simplified remote voice assistant to navigate internet, kind of limited without internet. Have it use olden slang to resonate with the older generation	An all in one remote, replacing the use of touch screens with a remote control buttons for ergonomics	Camera embedded into remote i guess, this is basically a phone that is embedded into a remote... Idk
Make it very easily understandable, have a built in tutorial or guide to help them navigate the device.	Make it super universal so it doesn't just apply to television. Can be hooked up to other devices like smart bulbs and stuff.	Add ability to connect to smart phones so they can take pictures from afar?? Idk
could make this into a monetizeable thing so like we partner with cable companies to provide their customers with extra programmable chips for their remote to include the new channels and shows being offered lol	at that point it would probably be simpler to just make it a phone app	can make it like a laser pointer or something instead?
Do new channels ever get added or do they just move around to different bands/get replaced? Either way, could probably get cable companies to pay us for making their stuff more accessible.	(smart)phones already can call through voice commands so idk if it would be useful as a phone app	Camera could go on the tv and do video calls on the tv screen too?
make a detailed manual about how to use the device, try to make it local to the TV so old folks don't have to deal with the internet; TRAVIS responds to voice inputs like "Okay partner, navigating to channel 165". Has a southern accent. Good ol Travis	make it possible to connect to landlines in the house as well so can dial number or quick call someone for you, would be overly complicated	have camera on top of remote, hold up like a smartphone and display face on TV and person who is calling

Reflections on Brainstorming and 6-3-5:

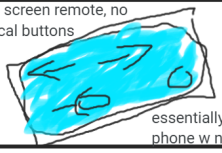
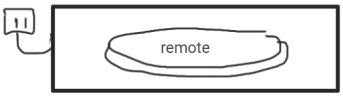
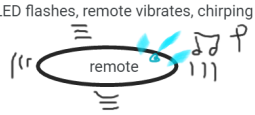
Since the group already had an idea of what we wanted to do, we found the brainstorming technique to be a bit more helpful. We were able to collaborate and receive feedback on ideas immediately instead of waiting to see how ideas developed with the 6-3-5 method. We felt that the 6-3-5 method would have worked better for us if we did it closer to the beginning, because doing it later into the project felt like brainstorming with additional constraints.

Morphological Chart:

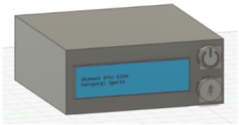
CSE123G9
Morphological chart
02/02/2022

TV Remote
Morphological Chart

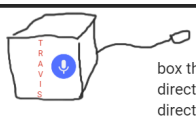
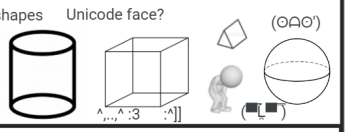
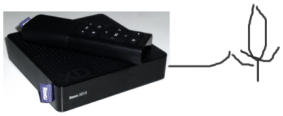
maybe dedicated buttons for favorite channels?

	input method	button layout	other features
	general remote style 	 channel up/down, vol up/down, power, mute, voice button	 keypad input with cover if it gets fat-fingered often
	touch screen remote, no physical buttons  essentially phone w no OS	 above design + keypad	 wireless charging plate
	pure audio remote 	only audio related buttons 	if lost, LED flashes, remote vibrates, chirping noise 

CSE123G9
Morphological chart
02/02/2022

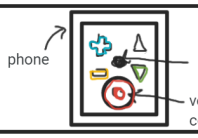
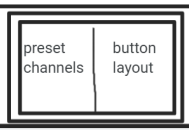


Alexa Box
Morphological Chart

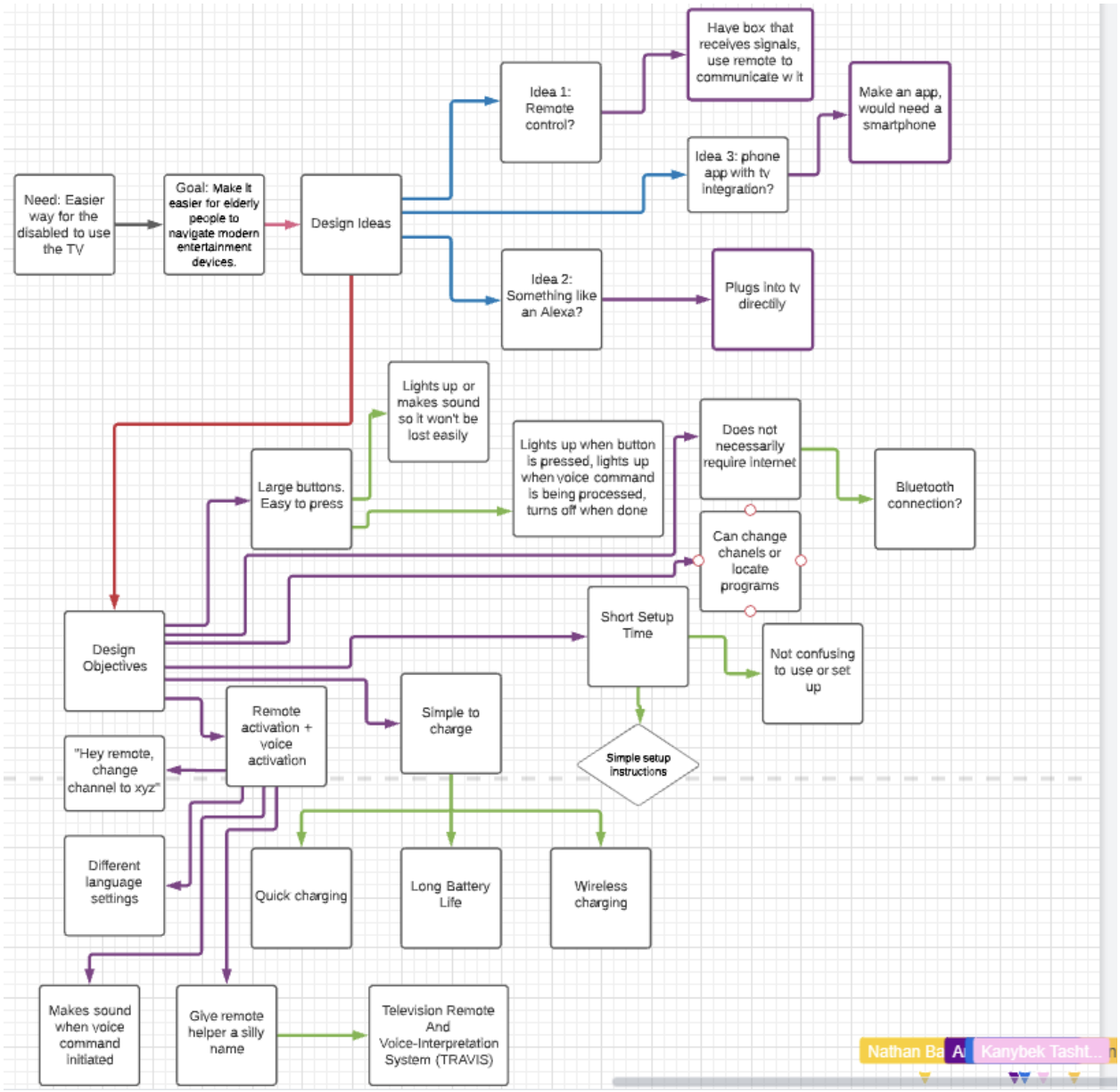
	technology	TV connection style	T.R.A.V.I.S. Features
	 custom cable box	 box that plugs directly into TV w/ direct voice input	shapes Unicode face? 
	 roku/alexa app with potential add'tl hardware	 IoT?	Robot Lady voice. Generic but trustworthy one of our voices with preset responses Text to speech database? texan accent, fall in love with TRAVIS?
	 custom alexa style soundbox	 Sends IR signals to TV/emulates remote inputs	have TRAVIS respond to input "Changing to Channel 145" or "I'm sorry, did you mean this?" small lad

CSE123G9
Morphological chart
02/02/2022

Phone App
Morphological Chart

	Layout	Features	Way of Registering Commands
		one page with list of preset channels, one page of buttons, one page showing current channel number and program name	custom database/neural network training Predicts what you want to watch based on past behavior
	 -Channel display -Mute button -Slider to switch between changing channel and volume	Search bar or search engine of available channels. Can input streaming services you are subscribed to. Will add them and your cable plan to app's search list. Will try to play what you choose	text to speech + speech to text - use already created open source software Confirmation before continuing with command
	better for a tablet 	Has a favorites list that can tell the TV to alert the user when a show is playing on a specific channel or if their show is appearing on any channel Favorite channel speeddial option	Options in-app to set alarms/reminders/ notifications for when a show is playing. Sleep timer & time-limiting options

Mind Map:


Need: Easier way for the disabled to use the TV
Goal: Make it easier for elderly people to navigate modern entertainment devices.
Design Ideas
Idea 1: Remote control?
Have box that receives signals, use remote to communicate w it
Idea 3: phone app with tv integration?
Make an app, would need a smartphone
Idea 2: Something like an Alexa?
Plugs into tv directlly
Design Objectives
Large buttons. Easy to press
Lights up or makes sound so it won't be lost easily
Lights up when button is pressed, lights up when voice command is being processed, turns off when done
Does not necessarily require internet
Bluetooth connection?
Can change chanels or locate programs
Short Setup Time
Not confusing to use or set up
Simple setup instructions
Remote activation + voice activation
Simple to charge
"Hey remote, change channel to xyz"
Different language settings
Quick charging
Long Battery Life
Wireless charging
Makes sound when voice command initiated
Give remote helper a silly name
Television Remote And Voice-Interpretation System (TRAVIS)

Decision Table:

Criteria	Weight	Design 1: Remote		Design 2: TV Box		Design 3: App	
		Raw	Weighted	Raw	Weighted	Raw	Weighted
Cost	10	4	40	2	20	5	50
Device Uptime	10	4	40	5	50	2	20
Task Startup Time	15	1	15	4	60	3	45
Voice Recognition Accuracy	25	2	50	2	50	2	50
Damage Likelihood (External)	5	3	15	4	20	5	25
Average Lifetime (Internal)	10	5	50	2	20	5	50
Recycleability	5	5	25	1	5	5	25
Setup Time	15	5	75	5	75	5	75
Manufacturing Cost	5	4	20	2	10	5	25
Total	**100**	**33**	**330**	**27**	**310**	**37**	**365**

Reflections on Decision Table:

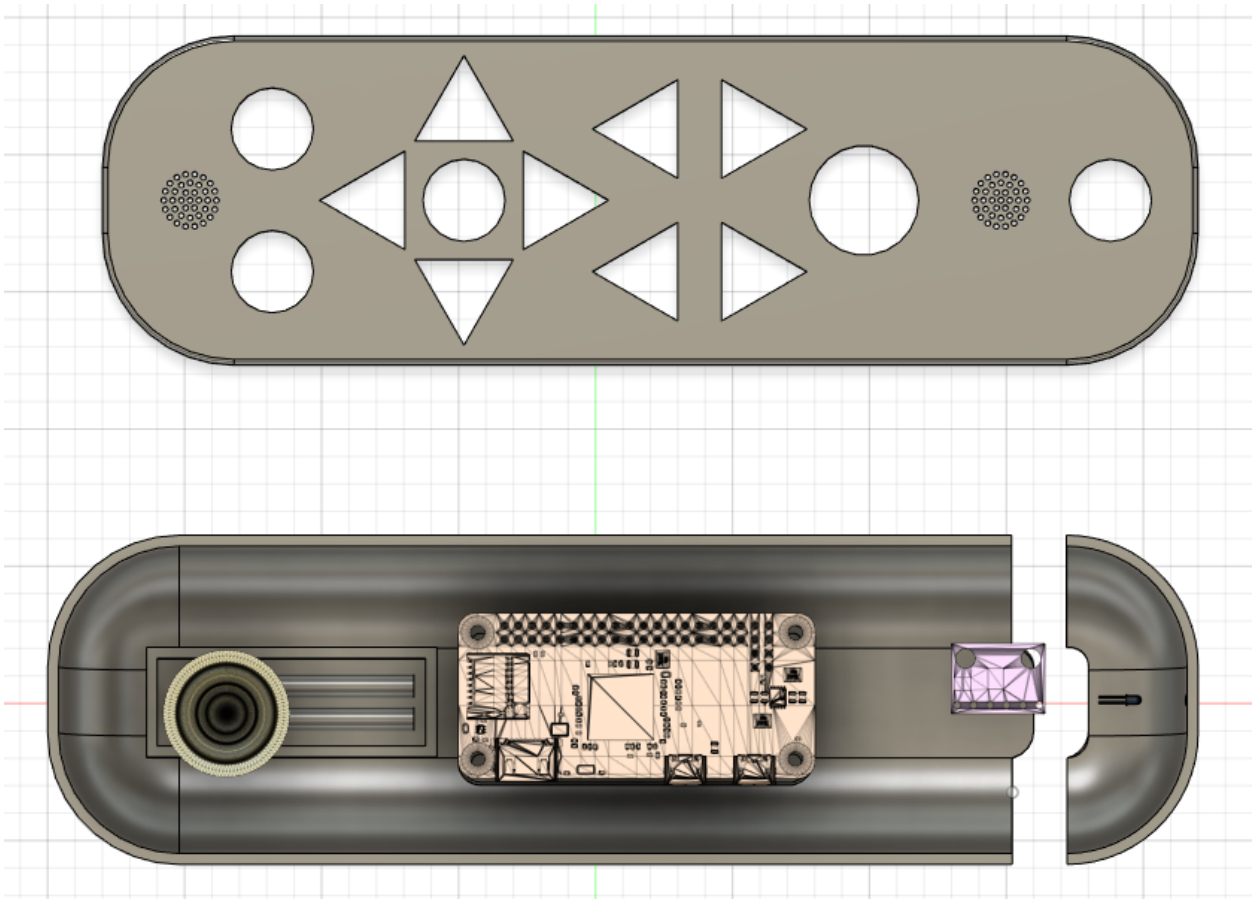
While coming up with various metrics, we realized that the inclusion of the app as a main design idea introduced a lot of factors that other designs couldn't compete with, i.e. that we would likely not need a manufacturing cost, that the app only breaks when the phone breaks, etc. Because this decision table must be quantifiable, and we would have trouble quantifying user experience at this stage, a lot of the flaws for the app version do not show through and instead the strengths of the medium are overrepresented. For example, ease of use was not a factor that we could easily quantify but is a concern with the app, especially for older people who do not have smartphones. The app design also doesn't consider the cost of a smartphone, which can vary depending on brand and model, and the cost of a base product, other than a TV, is not applicable to the other designs.

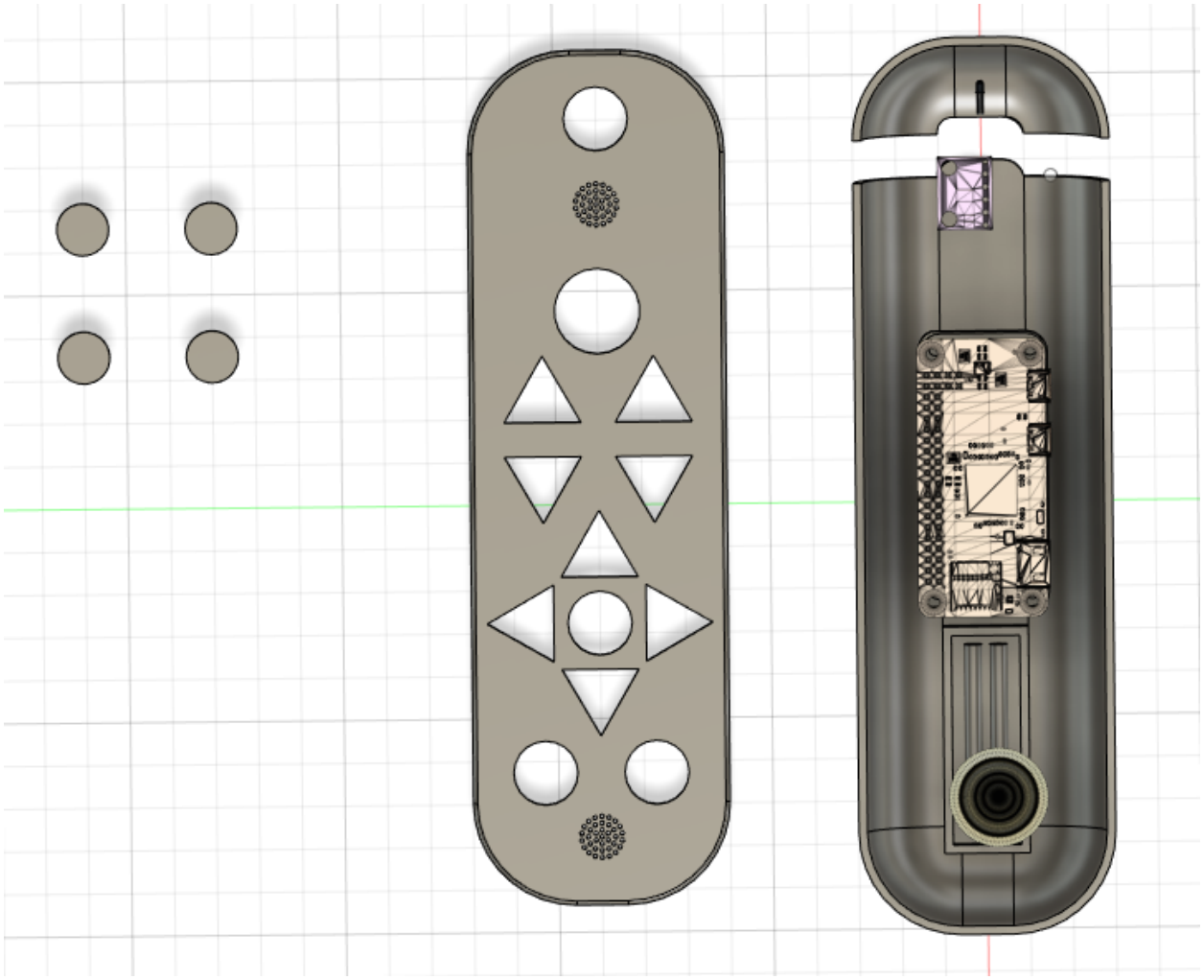
Similarly, because we have product costs and manufacturing costs, some parts of our designs are double-counted. We felt both criteria were too important to exclude, but it introduced an effect where money factored in higher than what we would have liked. Similarly, because our guesses for the average end-product cost and manufacturing costs were similar on the scales we used, they ended up just compounding.

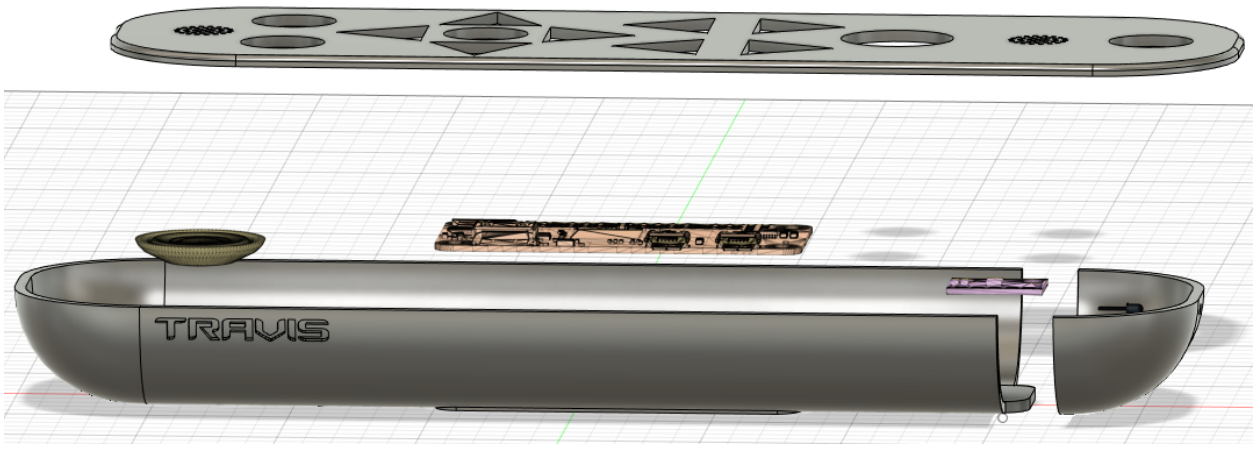
At the end of the day, we convened and decided that the app, while good on paper, does not have the ease of use we want for our product. We decided to continue with the original remote control idea as we feel that it would score the best on the user-experience bracket because

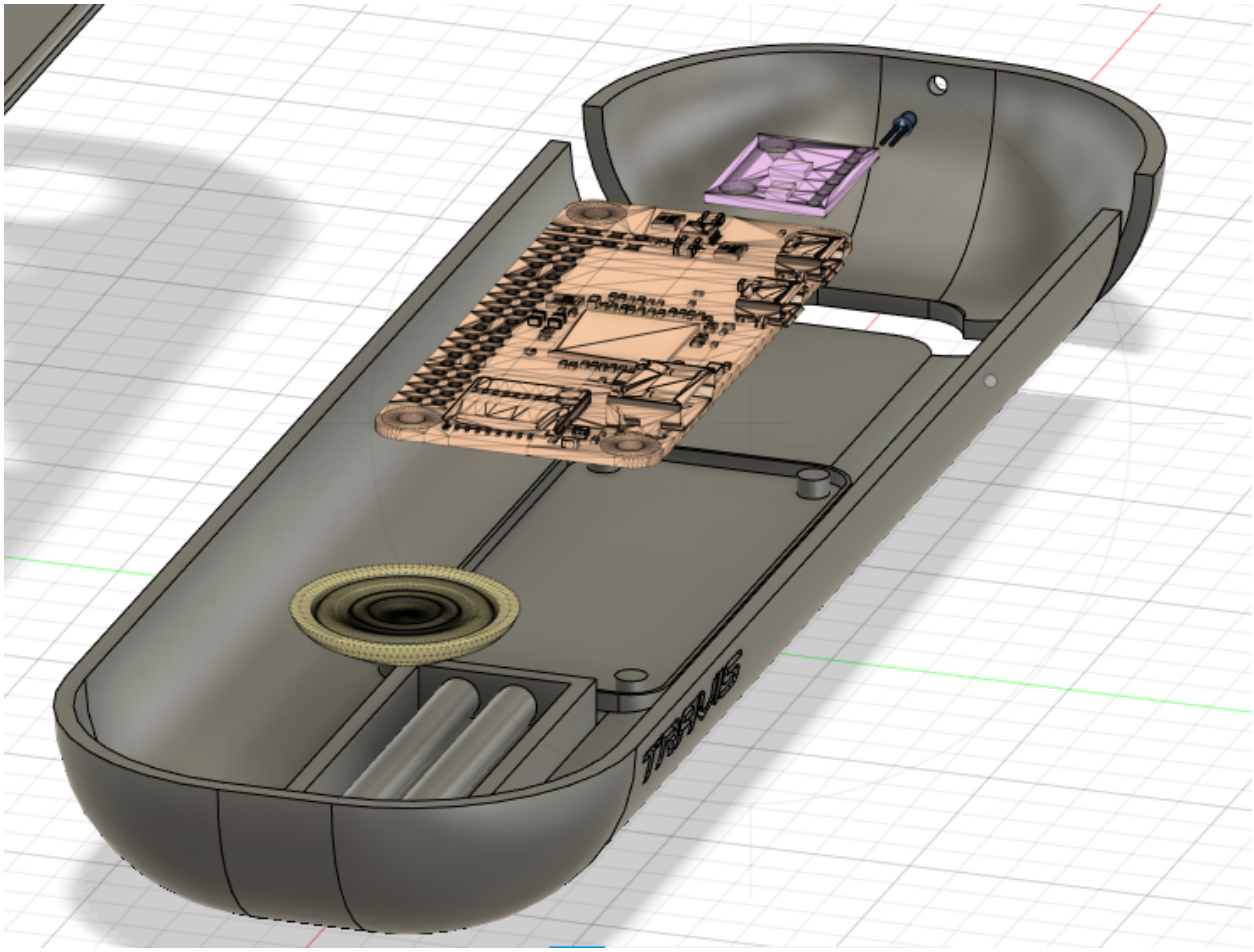
of the physical buttons involved. Besides that, we would much rather make a physical product over a phone app.

Free Format Description of Design:






TRAVIS



Our current design looks like the above - note that the internal mountings for each component are currently unfinished. We do not have a complete wiring schematic ready to include here, but we don't foresee any major issues with creating it. Wiring to our Raspberry Pi via GPIO pins should be simple. The only issue we foresee is having more inputs than we have space for. In that case we will need to extend certain signals.

See our DFM below for more details:

Design for Manufacture and Assembly:

The external design for our remote is composed of two pieces (a top and bottom) that snap together to form the main remote shell, with an additional clear component for our IR transmitter to shoot through (at the front end of the remote), and a removable cover for our battery case (on the bottom of the back end). All of these external plastic components will clip together in our final design, with the intention that all except the battery case door will be hard to separate once together. Our design includes 13 buttons, as listed here:

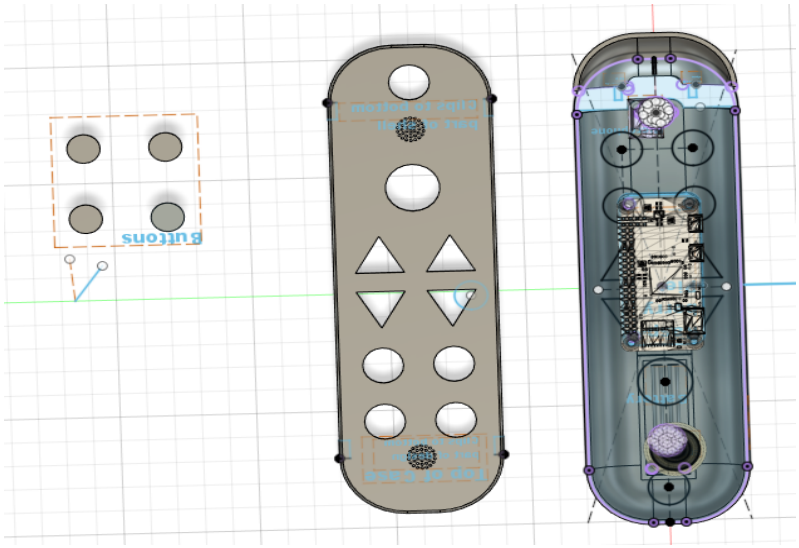
TV On/Off
Remote Voice Input Activated/Deactivated

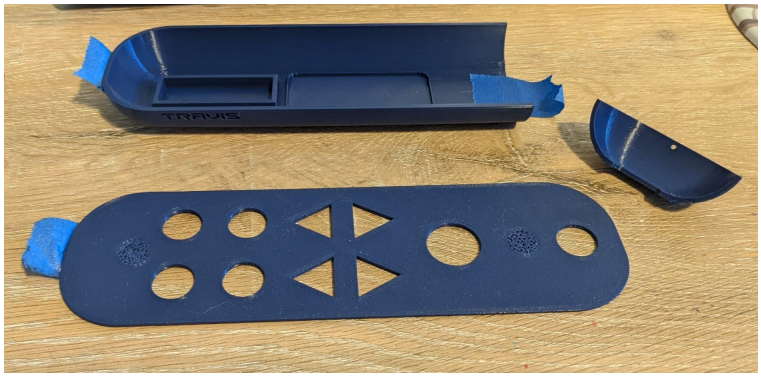
Cursor Up, Down, Left, and Right
Select
Channel Up and Channel Down
Volume Up and Volume Down
Source
Mute

Each button is roughly the size of a quarter. The buttons will be glued on to their switches.

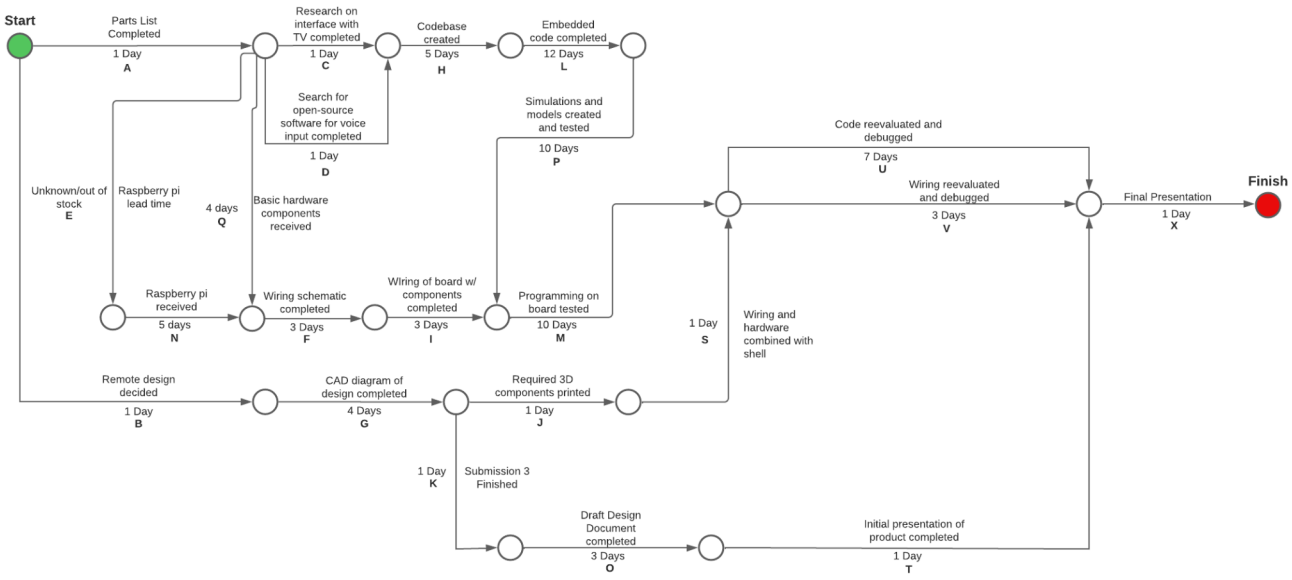
The internal design is composed of a Raspberry Pi, battery, speaker, microphone, IR transmitter (LED), and buttons that hook up to the external rubber ones (not included in this current draft). The microphone is located below the power button and the speaker is located in the bottom half of the remote, above the battery. The Raspberry Pi is located between the speaker and microphone, adjacent to the battery. There will be two mounting points to align the RPI and two screws to keep it secure. We will add similar measures for the other internal components if experiments deem them necessary.

Shown below is a previous CAD diagram and a 3D printed copy of the design.





CPM:



We have two notable critical paths in this project. The first path includes waiting on all of our parts to arrive and completing the wiring portion of the project. This path is A, Q, F, I, M, V and we estimate it will take about 24 days. We estimate it will take about 4 days for us to receive all of the basic hardware components. We are unsure how long it will take for us to receive the Raspberry Pi because it is out of stock so we did not include this event in our time estimate. We estimate it will take about 5 days for the Raspberry Pi to arrive once it is back in stock. The largest delay on this path is 10 days, which is how long we expect full testing of the wired and programmed board to take.

The second notable critical path is the path for creating the code and completing testing. This path is A, C, D, H, L, P, M, U and takes 47 days. The largest time delay on this path is caused by programming and testing. The path may not take the full 47 days because some tasks, such as completing the embedded code and simulating and testing it, can be done concurrently by multiple members, reducing the total time of the critical path.

The delay caused by the Raspberry Pi obstructs part of the CPM, but we can still create code and perform most of the necessary testing with a different Raspberry Pi while we wait for the part.

Budget for Prototype:

Name	Link	Amount	Cost (Each)	Tax + Shipping	Cost (Total)	Availiabilty/Lead	Reasoning	Status
Raspberry Pi Zero 2 W	https://www.raspberrypi.com/products/raspberry-pi-zero-2-w/	3	$15.00		$45.00	~2 week lead time out of stock, on notification list	Microcontroller is necessary to be able to program on and provide a hub for associated embedded devices This specific RP provides good power for the price and is small enough to comfortably fit within a remote controller. Katy is on list for: pishop.us, sparkfun	Waiting for email
I2S MEMS Microphone Breakout	https://www.adafruit.com/product/3421	1	$6.95	$0.64	$7.59		Microphone output	Ordered 2/14, Shipped 2/16, Arrived 2/18
Super-bright 5mm IR LED - 940nm	https://www.adafruit.com/product/387	5	$0.75	$0.35	$4.10		Light indicator for when button is pressed to show it is working	Ordered 2/14, Shipped 2/16, Arrived 2/18
Soft Tactile Button (8mm) x 10	https://www.adafruit.com/product/3101	1	$1.95		$1.95		We need the user to be able to press the buttons to control their TV and other settings	Ordered 2/14, Shipped 2/16 Arrived 2/18
Mini Metal Speaker w/ Wires - 8 ohm 0.5W	https://www.adafruit.com/product/1890	1	$1.95		$1.95		Volume output so the device can confirm commands	Ordered 2/14, Shipped 2/16 Arrived 2/18
Stereo 3.7W Class D Audio Amplifier	https://www.adafruit.com/product/987	1	$8.95		$8.95		Other option for speaker	Ordered 2/14, Shipped 2/16 Arrived 2/18
Cost of Top Rows:			$35.55	$0.99	$69.54			
Universal Qi Wireless Charging Transmitter	https://www.adafruit.com/product/2162	1	$26.95		$26.95		Way to keep the device charged in a way more sustainable than just a battery. Need this for transmitting power.	
Universal Qi Wireless Charging Module - 20mm Reverse MicroUSB	https://www.adafruit.com/product/2114	1	$24.95		$24.95		Way to keep the device charged in a way more sustainable than just a battery. Receives Power from transmitter.	
3d Printing Filament - Biodegradeable, Algix ALGA Algae Based PLA 3D Printer	https://www.3dprintlife.com/alga	1	$34.99	$0.00	$34.99		We need filament to be able to 3d print, and making it biodegradeable is a bonus. Water-soluble, biodegradable material for the remote shell. High contrast color preferred, available atm: natural(brown), tan, dark red, slate grey. Con: their	
Universal Qi Wireless Receiver Module	https://www.adafruit.com/product/1901	1	$14.95		$14.95		Wireless Charging Receiver, alteranative to other receiver	
Mini Lipo w/ mini USB Jack	https://www.adafruit.com/product/1905	1	$6.95		$6.95		Breakout board that pairs with LP battery for wireless charging	
Lithium Ion Polymer Battery	https://www.adafruit.com/product/258	1	$9.95		$9.95		LP battery that can be wirelessly charged to power remote.	
Cost of Bottom Rows:			$101.84	$0.00	$118.74			
Total Cost:			$137.39	$0.99	$188.28			

New Parts List: 2/23								
Name	Link	Amount	Cost (Each)	Tax + Shipping	Cost (Total)	Availiabilty/Lead Time	Reasoning	Ordered by Katy
Tactile Switch Buttons (12mm square, 6mm tall) x 10 pack	https://www.adafruit.com/product/1119	2	$2.50		$5.00		Remote buttons	Ordered 2/24
I2S MEMS Microphone Breakout	https://www.adafruit.com/product/3421	1	$6.95	$0.64	$7.59		Microphone output	Ordered 2/24
Mini Metal Speaker w/ Wires - 8 ohm 0.5W	https://www.adafruit.com/product/1890	1	$1.95		$1.95		Volume output so the device can confirm commands	Ordered 2/24
Stereo 3.7W Class D Audio Amplifier	https://www.adafruit.com/product/987	1	$8.95		$8.95		Other option for speaker	Ordered 2/24
Super-bright 5mm IR LED - 940nm	https://www.adafruit.com/product/387	5	$0.75	$0.35	$4.10		Light indicator for when button is pressed to show it is working	Ordered 2/24
Tactile Switch Buttons (6mm tall) x 10 pack	https://www.adafruit.com/product/1490	2	$2.50		$5.00	out of stock	Remote buttons	
TOTAL					$27.59			

Our budget includes a Raspberry Pi, microphone for voice input, LEDs for light indicators, buttons, and a speaker and Class D Amplifier for potential vocal feedback from the remote AI. We included wireless charging components in the budget, but after reviewing the costs we realized that the expenses involving wireless charging doubled the cost of our prototype. We decided to use regular batteries for our project and to implement the wireless charging features later if we have time and decide it is worth the extra expense.

Life Cycle Assessment:

Energy use (in manufacturing and operation, how long, power use):

- **Manufacturing:** 11 hours to print shell, average power draw for 3D printers is 70W, 0.77kWh for 11 hour print
  - Source:https://3dprinterly.com/how-much-electric-power-does-a-3d-printer-use/
- **Operation:**

Resource use:

- **Material source**:
  - Raspberry Pi (based on A+ model): circuit board and CPU made of Silicon Dioxide, found in sand, and mined copper. Electrical parts are made of tin and precious metals. Materials used while processing raw materials include epoxy resin, photo resist, and tin.
    - Source: http://www.designlife-cycle.com/raspberry-pi
  - Shell: PLA plastic: vegetable-based plastic material, uses cornstarch as raw material. Made from fermented plant starch and primary natural material in filament.
    - Source:https://www.sculpteo.com/en/materials/fdm-material/pla-material/#:~:text=PLA%20plastic%20or%20polylactic%20acid,material%20used%20in%203D%20printing.
- **Material usage**:
  - **Manufacture:** 65g filament for printing, Raspberry Pi, speaker, microphone, LED, miscellaneous wires
  - **Operation:**
- **Transportation**: Parts had to be transported to residence before assembly.
- **Renewable**: Powered by electricity, potentially renewable depending on the power source. Parts of internal hardware are recyclable but not renewable. Shell filament made with renewable raw materials.
- **Disposal**: Shell is partially biodegradable(dependent on filament). Shell has potential to be recycled but needs special treatment because of lower melting point than other plastics. Shell filament can also be reused. Components on Raspberry Pi and in other hardware can be reused. Metals on pcb are extracted via acid leaching, and recycled or reused, but leftover residues go to landfill. Some plastics of internal hardware can be recycled.
  - Source:https://www.sciencedirect.com/science/article/pii/S1878029616301499#:~:text=PCBs%20contain%20a%20lot%20of,reused%20based%20on%20their%20status.
  - Source: https://all3dp.com/2/is-pla-recyclable/

Outstanding Issues:

Battery life may be a problem depending on the power cost of deciphering voice input, voice accuracy is as of yet undetermined and will be very important, and our preferred microcontroller, the Raspberry Pi Zero 2 W, is out of stock.

Appendix

Models and Simulations:

N/A as of yet.

CPM Inputs:

Activity	Duration (day/s)	Preceded by
A	1	–
B	1	–
C	1	A
D	1	A
E	1	A
F	3	A, E, Q, N
G	4	B
H	5	A, D, C
I	3	A, E, Q, N, F
J	1	B, G
K	1	B, G
L	12	A, D, C, H
M	10	A, C, D, H, L, P, E, N, Q, F, I
N	5	A, E
O	3	B, G, K
P	10	A, C, D, H, L, P

Q	4	A
S	1	B, G, J
T	1	B, G, K, O
U	7	A, C, D, H, L, P, E, N, Q, F, I, M, B, G, J, S
V	3	A, C, D, H, L, P, E, N, Q, F, I, M, B, G, J, S
X	1	A, C, D, H, L, P, E, N, Q, F, I, M, B, G, J, S, K, O, T, U, V

Decision Table Inputs:

Evaluation Scale

Criteria	**Units**	**Design 1 Remote**	**Design 2 TV Box**	**Design 3 App (only this app)**
Cost	US Dollars [$]	25	50	10
Device Uptime	hours	> 1k	Always	20 < x < 50
Task Startup	Seconds	5	1 - 2	2 - 3
Voice Recognition Accuracy	Qualitative (% words recognized)	> 60	> 60	> 60
Damage Likelihood (External)	% (Newtons of force? Passed drop tests?)	10	2	N/A
Average Lifetime (Internal)	Years	10	5	Could be infinite with proper updates
Recyclability	% material that is recyclable	> 90	> 50	N/A
Ease of use	Qualitative (Survey fill out?)	> 75%	> 75%	> 75%

Manufacturing Cost	US Dollars [$]	< 10	< 25	> 25
Setup Time	Minutes	5	5	2

Evaluation Scale for Ranges: Numeric Scores

Cost Range (Dollars $)	**Device Uptime Range** (Hours)	**Task Startup Time Range** (Seconds)	**Voice Recognition Accuracy Range** (%)	**Average Lifetime (Internal) Range** (Years)	**Recyclability Range** (Percent %)	**Numeric Score**
x <= 15	Always	x <= 1	90 < x <= 100	x >= 10	90 < x <= 100	x5
15 < x <= 30	1k <= x	1 < x <= 2	80 < x <= 90	8 <= x < 10	80 < x <= 90	x4
30 < x <= 45	100 < x <= 1k	2 < x <= 3	70 < x <= 80	6 <= x < 8	70 < x <= 80	x3
45 < x <= 60	10 < x <= 100	3 < x <= 4	60 < x <=70	4 <= x < 6	60 < x <= 70	x2
60 <= x	x <= 10	4 < x	x <= 60	x <= 4	x <= 60	x1

Setup Time (Minutes)	**Damage Likelihood (External)** (Percent %)	**Manufacturing Cost** ($)	**Numeric Score**
x <= 15	N/A	x <= 5	x5
15 < x <= 30	x <= 5	5 < x <= 10	x4
30 < x <= 45	5 < x <= 10	10 < x <= 15	x3
45 < x <= 60	10 < x <= 15	20 < x <= 25	x2
60 <= x	15 <= x	x > 25	x1

Weights

Criteria	**Weight**
Cost	10
Device Uptime	10

Task Startup Time	15
Voice Recognition Accuracy	25
Damage Likelihood (External)	5
Average Lifetime (Internal)	10
Recyclability	5
Setup Time	15
Manufacturing Cost	5
Total	100

Test Plan:

Product Durability:

Test #	Date	Location	Members Present	Goal/Purpose	Parameters (w/ justification)	Hypothesis/Expectations	Independent Variables	Independent Variables' Settings	Dependent Variables
1		BSOE Lab 250/252		Testing durability of remote shell.	Fresh printed shell, Standard electronics layout, fully assembled product.	Can survive most drops and continue functioning	Drop height, drop force, surface dropped upon.	1 Meter Drop height, No force beyond gravity, Concrete floor surface	Reported damage (internal and external), continued viability of product
2		BSOE Lab 250/252		Testing durability of remote shell at different heights (when does shell pop open? physical wear and tear?	Remote shell w/o hardware, yard stick (for measuring heights), hollowed cardboard box (drop site barrier, keep pieces from scattering)	Remote will survive most drops with wear and tear directly proportional to an increase in height	Drop height, landing site	at least 5 drops from different heights up to 10ft, no external force acting on remote besides gravity, concrete landing site	Shell damage

Testing Method	Testing Method: Significance	Sampling Procedure	Sampling Procedure: Method	Sampling Procedure: # of Samples	Procedure (Step-by-step)	Procedure: Safety Precautions	Procedure: Data Collection Method	Other Factors
Drop onto specific surface from X height up with Y specific additional downwards force.	This should (mostly) cover expected scenarios of our remote being dropped out of someone's hands or knocked off someone's table. Thus we need to see the expected damage from such actions to prevent future problems with our product	Sample taken after single drop, noteworthy results after continued drops have been noted in the summary	Report on seen external damage, open casing and check for internal damage (e.g. loosened wires), and test if remote shut off and if it is still operational within seemingly normal bounds.	15	0. Wear PPE, clear area of easily damageable goods. 1. Grab remote, hold up to given height above the ground. 2. Let remote tumble out of hand, potentially add additional force if testing for such. 3. Note down the orientation and rotational speed (subjectively) at the moment the device hit the floor. 4. Pick up remote, inspect for exterior damage, note this down. 5. Unclasp casing, inspect for interior damage, note this down. 6. Reseal product, test for continued operation and additional perameters. Note down operational status and perceived issues, if any. 7. Repeat steps 1-6 until desired number of samples taken.	Safety glasses warn at all times to protect against potential flying debris, rubber gloves used when checking device's internal electrical components for damages to prevent against potential shocks. Additionally, clear area of easily damageable goods (e.g. glass bottles).	Exterior damage: Inspect for any scratches, chips, damaged or lost buttons, and obviously damaged portions. Interior damage: Inspect for broken wires, sparking components, damaged soldering, loose components, and so on. Continued operational viability: Check if remote is still on, and if so if it is still functioning within bounds. Note if any queries take longer than normal or if significant reductions in audio processing capabilities have occured.	Experiment went smoothly with no additional factors of note.
Drop remote shell from various heights and make a qualitative assessment of the damage, damage will compound unless different shells are used, start from lowest height	Testing to be able to ensure consumer that shell will adequately protect the inner hardware of the remote. Older or disabled people may be less dextrous with hands, ensure remote will survive being dropped.	Note visible wear and tear after each drop.	Note visible wear and tear on inside and outside of shell for each height	3 at each height	0) wear safety glasses, clear area 1) Drop remote from marked height, note visible damage 2) Repeat step 2 three times at each predetermined height 3) repair remote between each drop if possible (such as snapping remote back together)	Beware of shrapnel from remote, wear safety glasses if near drop zone		

Dependent Variables' Outcomes	Summary
Y/N internal damage reported, Y/N external damage reported, product remained viable and performed within bounds of other test results.	Remote is robust to faults from dropping from low heights on very hard surfaces.

3		BSOE Lab 250/252		Testing water resistance of shell	Freshly printed shell, no electronics inside	The shell will most likely not keep out water at all	Type of water, water volume location	A few litres of regular tap water	Volume of water inside the shell afterwards
4		BSOE Lab 250/252		Testing scratch resistance of shell	Partial fresh printed shell, no electronics inside	Shell will be reasonably scratch resistant to accidental scratches, hard scrape with sharp object will definitely scratch	Scratching implement	pocket knife, butter knife, hard plastic, other scratching implement	shell damage

Submerge the remote shell in tap water for varying amounts of minutes. Record results	This should prove whether or not the remote is durable enough to prevent water from ruining the electronics, which will be better for older and/or disabled folks sincespills may be common in the household	Measure the amount of water present inside the shell after testing has occured	See where the water accumulates if at all and where the weakpoints of the remote are that allow the most water in	Different situations of water tests (e.g. spilling a cup, dropping it into a tank of water, droplets spilling onto the remote, etc.). Most likely 5-8 tests	1) Assemble the remote shell together 2) Either submerge the remote in water or pour it on top 3) Wait for varying amounts of time and dry the outside of the case 4) Check the inside for water entry points and how much accumulated 5) Repeat steps 1-4 for different types of liquid submergence/spread and for different timings	Make sure there are no electronics inside the remote for risk of electrocution and wasting supplies
Place partial of shell on hard surface, secure with tape or other means to prevent sliding, scratch portion with object	Shows how scratch resistant/resistant to damage the remote is. Particularly important for fancy implementation with wireless charging to show consumer product will last	Note outer shell after scraping at different pressures and/or with different implements		2 tests with each pressure and implement, 6-8 in total	1) Secure remote shell to work surface 2) Scratch surface of shell at different pressures 3) Note depth of scratch or if scratch occured 4) Repeat as necessary 5) Clean work area of any debris, dispose of properly	Wear gloves when handling scratching implements, safety goggles recommended

Battery Life:

Test #	Date	Location	Members Present	Goal/Purpose	Parameters	Hypothesis/Expectations	Independent Variables	Independent Variables' Settings	Dependent Variables
1		BSOE Lab 250/252		Testing battery life w/ regular AA batteries (min)	2 fresh AA batteries, fully completed standard electronics setup.	Battery lifetime will go down as voice input increases, but button-related input will have a much more minor effect on the battery life.	Button usage (% of time per minute), voice input usage (% of time per minute), TRAVIS voice responses enabled/disabled, TRAVIS voice input receiving/disabled.	Button usage @ 0%, voice input usage @ 10%, TRAVIS voice responses enabled, TRAVIS voice input receiving.	Duration batteries last before there is not enough power to continue functioning.
2		BSOE Lab 250/252		Testing battery life with wireless charging (min)	Wireless receiver and transmitter, Li-ion battery, internal hardware	Battery lifetime will go down as voice input increases, but button-related input will have a much more minor effect on the battery life.	Button usage (% of time per minute), voice input usage (% of time per minute), TRAVIS voice responses enabled/disabled, TRAVIS voice input receiving/disabled.	Button usage @ 0%, voice input usage @ 10%, TRAVIS voice responses enabled, TRAVIS voice input receiving.	Duration batteries last before there is not enough power to continue functioning.

Testing Method	Testing Method: Significance	Sampling Procedure	Sampling Procedure: Method	Sampling Procedure: # of Samples	Procedure (Step-by-step)	Procedure: Safety Precautions	Procedure: Data Collection Method
Provide automated voice and button input at provided levels of duration per minute with given voice settings. Have TRAVIS log every 10 minutes so that when TRAVIS runs out of battery we will be able to find within a reasonable amount of time how long it lasted.	By keeping this process automated we can have these tests running concurrently with other production and not need to worry about constantly checking in on it and thus wasting the time of our team.	Due to the duration of these tests, only a single sample per delta of independent variables will be taken, as these batteries may last a long amount of time and already have prescribed tolerances we can assume they will adhere to.	Upon TRAVIS power off, plug into stable power supply and copy the total time TRAVIS' log reports running for.	1	0: Store TRAVIS within sound-dampened container nearby TV, ensure fresh batteries have been supplied to TRAVIS. 1: Set up laptop next to TRAVIS to input given settings and automated inputs. 2: Turn on TRAVIS and begin sending in signals via laptop. 3: Occasionally check in on TRAVIS to check when it runs out of power. 4: When TRAVIS runs out of power, hook TRAVIS up to a stable power supply and collect data from its timing log. 5: Repeat with different independent parameters.	TRAVIS to be kept within sound-dampened container so as to minimize audio interference for others using the same office space.	Data collection to occur by reading log file output by TRAVIS, then recording the duration it was on for within this spreadsheet.
Provide automated voice and button input at provided levels of duration per minute with given voice settings. Have TRAVIS log every 10 minutes so that when TRAVIS runs out of battery we will be able to find within a reasonable amount of time how long it lasted.	By keeping this process automated we can have these tests running concurrently with other production and not need to worry about constantly checking in on it and thus wasting the time of our team.	Due to the duration of these tests, only a single sample per delta of independent variables will be taken, as these batteries may last a long amount of time and already have prescribed tolerances we can assume they will adhere to.	Upon TRAVIS power off, plug into stable power supply and copy the total time TRAVIS' log reports running for.	1	0: Store TRAVIS within sound-dampened container nearby TV, ensure fully charged battery has been supplied to TRAVIS. 1: Set up laptop next to TRAVIS to input given settings and automated inputs. 2: Turn on TRAVIS and begin sending in signals via laptop. 3: Occasionally check in on TRAVIS to check when it runs out of power. 4: When TRAVIS runs out of power, hook TRAVIS up to a stable power supply and collect data from its timing log. 5: Repeat with different independent parameters.	TRAVIS to be kept within sound-dampened container so as to minimize audio interference for others using the same office space.	Data collection to occur by reading log file output by TRAVIS, then recording the duration it was on for within this spreadsheet.

Battery Charging Speed:

Test #	Date	Location	Members Present	Goal/Purpose	Parameters	Hypothesis/Expectations	Independent Variables	Independent Variables' Settings	Dependent Variables
1		BSOE Lab 250/252		Testing charging speed with wireless charger	wireless transmitter/receiver, LIP battery and breakout board, stopwatch connected to state that says battery fully charged		wireless transmitter/receiver, LIP battery and breakout board		charging time

Testing Method	Testing Method: Significance	Sampling Procedure	Sampling Procedure: Method	Sampling Procedure: # of Samples	Procedure (Step-by-step)
place fully depleted LIP battery on charging station and time how long it takes for the battery to be fully charged	Determining how long it takes for remote to reach a full charge				1) setup up wireless charging station 2) place battery on charging station 3) wait until full charge is reported, write down time

Audio Recognition Accuracy:

Test #	Date	Location	Members Present	Goal/Purpose	Parameters	Hypothesis/Expectations	Independent Variables	Independent Variables' Settings	Dependent Variables
1		Closet or quiet room		Testing audio recognition without background noise	remote control hardware	Remote will be able to interpret most voice commands without background noise	hardware, voice input		Recognition quality (i.e. what words were picked up and what were not)
2		BSOE Lab 250/252		Testing audio recognition with background noise	remote control, TV	Remote will be able to interpret some voice commands with obstacle of background noise	hardware, voice input		Recognition quality (i.e. what words were picked up and what were not)
3		BSOE Lab 250/252		Testing voice recognition accuracy for different voices (young, old, teenager, young adult, middle-aged)	remote control, voice recordings	Remote will have difficulty interpreting slow speech and accents	Voices, electronics used for picking up audio	Age ranges of the voices, speed & volume at which they are talking, accents	Recognition quality (i.e. what words were picked up and what were not)

Testing Method	Testing Method: Significance	Sampling Procedure	Sampling Procedure: Method	Sampling Procedure: # of Samples	Procedure (Step-by-step)	Procedure: Safety Precautions	Procedure: Data Collection Method
Have someone speak predetermined phrase into microphone, have display show what the hardware heard and compare that to what was said	Testing if the voice recognition works when there are no external factors affecting its accuracy	Take notes of what words were understood by the system and what words either weren't or were omitted/misheard.	Note accuracy of what was heard vs what was said	3 tests for each voice recording, have at least 5 example commands, total: 15 samples	1)Prepare voice recognition software and hardware with a program to purely translate audio into text 2) Have person speak predetermined phrases into microphone 3) Examine results of what was heard vs what was spoken, compare results	N/A	Google doc
Have someone speak predetermined phrase into microphone, have display show what the hardware heard and compare to what was said	Testing reliability of voice recognition with background noise. Is voice recognition reliable with other people in the room? With someone making noise in another room?	Take notes of what words were understood by the system and what words either weren't or were omitted/misheard.	Note accuracy of what was heard vs what was said	3 tests for each voice recording, have at least 5 example commands, total: 15 samples	1)Prepare voice recognition software and hardware with a program to purely translate audio into text 2) Have person speak predetermined phrases into microphone 3) Examine results of what was heard vs what was spoken, compare results	N/A	Google doc
Have different voices play into the remote at differing speeds and volumes. Document results	Testing if the voice recognition is biased toward any voice. Testing how reliable voice recognition is for different voices (high-pitched, low-pitched, slow, fast, stilted)	Take notes of what words were understood by the system and what words either weren't or were omitted/misheard.	Report accuracy compared to a young adult talking at an average pace	3 for each speed per voice type, accent, etc.	1) Prepare voice recognition software and hardware with a program to purely translate audio into text 2) Have tester speak into the microphone with a specific accent, vocal age type, speed, etc. 3) Examine results compared to what was spoken 4) Compare accuracy of results to a control group (i.e. young adult talking at moderate pace) 5) Repeat steps 1-4 for different age groups, accents, speeds, etc.	N/A	

Test #	Date	Location	Members Present	Goal/Purpose	Parameters	Hypothesis/Expectations	Independent Variables	Independent Variables' Settings	Dependent Variables
4		BSOE Lab 250/252		Testing volume range remote can accurately respond to	remote control, voice recordings	Remote will have trouble with quiet voices	voices, electronics used for picking up audio		Recognition quality (i.e. what words were picked up and what were not)
5		BSOE Lab 250/252		Testing which member/s of the group the remote responds to regularly	remote control, voice recordings of group members	Remote will respond more accurately to one member's voice over the others	voices, hardware		Recognition quality (i.e. what words were picked up and what were not)
6		BSOE Lab 250/252		Testing accuracy of responses to questions from user	remote control, voice recording or live input	Remote will have trouble responding to question if it varies too much from expected input	voices, hardware		Recognition quality (i.e. what words were picked up and what were not)

Testing Method	Testing Method: Significance	Sampling Procedure	Sampling Procedure: Method	Sampling Procedure: # of Samples	Procedure (Step-by-step)	Procedure: Safety Precautions
have the same audio clip played at different volumes, document difference in what was heard vs what was said	Testing how the remote handles a range of input volumes. Does the remote have trouble understanding very loud voices and very quiet voices? How does accuracy diminish with distance?	Note what words were understood by the system and what words were omitted/misheard	Note accuracy of what was heard vs what was said	3 for each volume, test at quiet, medium, and loud, total = 9	1)Prepare voice recognition software and hardware with a program to purely translate audio into text 2) Play audio clips at different volumes 3) Document what was heard vs what was said 4) Repeat test with different types of voices at different volumes	N/A
play audio clip of each member's voice saying the same phrase, document which voice was recognized most accurately	Finding a voice that the remote will reliably respond to. Testing to see if accuracy is affected by masculine or feminine voices.	Play audio clips, document what was heard vs what was said	Note accuracy of what was heard vs what was said	3 for each member, 21 in total	1) Prepare voice recognition software and hardware with a program to purely translate audio into text 2) Play audio clip of each member's voice saying the same phrase 3) Document what was heard vs what was said 4) Repeat as necessary	N/A
play audio clips of variations of a question, document how remote responds	Testing to see if the remote can recognize a question/command and respond correctly and how program reacts if question isn't perfect	Play audio clips, document program response	Note accuracy of response to question	3 for each audio clip, 3 variations of question, at least 9	1) Prepare voice recognition software and hardware with a program to purely translate audio into text 2) Play variations of audio input 3) Document how the program responded, record whether met expectation or not 4) Repeat as necessary	N/A

Buttons:

Test #	Date	Location	Members Present	Goal/Purpose	Parameters	Hypothesis/Expectations	Independent Variables	Independent Variables' Settings	Dependent Variables
1				Testing button durability	Buttons that will face a variety of different hits with different pressures, timings, and durations (i.e. being pressed repeatedly for n minutes)	The buttons should be able to withstand a multitude of different presses and should last for a good bit of time	Button types, pressure and duration of presses and how often they will be pressed	Varying amounts of force, duration, and on & off periods Soft tactile buttons	Damage sustained and usability of the buttons after rigorous testing Amount of bouncing present afterwards
2				Testing button contact wear and tear					
3				Testing button reactivity/response time					
4				Testing accuracy/reliability of response to button input					
5				Testing "ease of use" of buttons					

Testing Method	Testing Method: Significance	Sampling Procedure	Sampling Procedure: Method	Sampling Procedure: # of Samples	Procedure (Step-by-step)	Procedure: Safety Precautions
Have one person apply various amounts of pressure and for different amounts of time Note durability and usability damages	This should show how much the buttons can take before they stop working either partially or altogether. It will allow us to figure out if we need to get more durable buttons or if we need to come up with more protection for said buttons	Button tested manually after each test. Check functionality and effectiveness based on factory new	Hook up button to program that allows us to press the button and test its functionality. Have a factory new button ready for comparison between it and the freshly tested one. Document results	3 timings for each level of pressure	1) Have button disconnected and ready to be pressed 2) Time the duration of the press and have the participant use as specific of an amount of pressure as possible 3) Release button and begin analysis 4) Compare to factory new button for feeling test 5) Hook up to program to compare functionality to factory new button. See if extra bouncing is present 6) Repeat steps 1-5 with varying times and pressures	Make sure the button is completely disconnected from all electronics before beginning testing in order to prevent electrocution as well as material waste

Television Remote Control:

Test #	Date	Location	Members Present	Goal/Purpose	Parameters	Hypothesis/Expectations	Independent Variables	Independent Variables' Settings	Dependent Variables
1				Testing ability to communicate with different TVs via IR	IR-sending hardware and software	The IR system should be able to handle multiple TV systems	IR hardware components & software libraries; TV being used	TV make and model	Accuracy of the signals sent on different televisions
2				Testing how reliable communication with one TV set is via IR	IR-sending hardware and software	The IR system should be reliable on a single TV system	IR hardware components & software libraries; TV being used	TV make and model	Accuracy of the signals sent
3				Test time it takes to configure the remote w/ a smart TV					
4				Test time it takes to configure the remote w/ a regular TV					
5				Test time it takes for an unassociated person to confiure the remote					

Testing Method	Testing Method: Significance	Sampling Procedure	Sampling Procedure: Method	Sampling Procedure: # of Samples	Procedure (Step-by-step)	Procedure: Safety Precautions
Have one person send various different IR signals to different TVs and see how many work correctly	This should accurately tell us how well the IR-sending library works and whether or not the hardware functions for multiple TV makes and models	Each IR signal manually tested. Functionality should be compared with proper TV remote	Send one IR signal at a time and check for what happens on the TV, if anything. Document results	Test each IR signal. Try 3 times for each. Try 3 different televisions	1) Have hardware and software connected. 2) Send IR signal to television 3) Analyze results and compare to factory new remote 4) Repeat steps 1-3 multiple times for all IR signals available on the remote 5) Repeat steps 1-4 for different TVs	N/A
Have one person send various different IR signals and see how many work correctly	This should accurately tell us how well the IR-sending library works and whether or not the hardware functions	Each IR signal manually tested. Functionality should be compared with proper TV remote	Send one IR signal at a time and check for what happens on the TV, if anything. Document results	Test each IR signal. Try 3 times for each	1) Have hardware and software connected. 2) Send IR signal to television 3) Analyze results and compare to factory new remote 4) Repeat steps 1-3 multiple times for all IR signals available on the remote	N/A

Test Results:

N/A as of yet.

Gantt Chart:

Task ID	Task Title	Task Members	Start Date	Due Date	Time Alotted (in Days)	% Task Completed	Phase (each phase is 3 weeks)
1	Submission 1	All	01/16/22	01/23/22	7	100	1
2	Individual Contribution 1	All(Individual)	01/30/22	02/04/22	5	100	2
3	Submission 2	All	01/24/22	02/06/22	12	100	2
4	Submission 3	All	02/07/22	02/20/22	13	100	2
5	Draft Design Document	All	02/22/22	03/06/22	13	70	3
6	Parts List Compilation	All	02/04/22	ongoing	--	--	3
7	Research on interface w/ TV	Nathan Banner, Ann Sophie	02/04/22	03/18/22	42	80	3
8	Codebase Creation						
9	Embedded Code Creation						
10	Search for Open-Source Voice Recognition Software	All	02/04/22	ongoing	--	30	3
11	Finish Schematic						
12	Simulation and Model Testing and Creation						
13	Programming on Board Testing						
14	Remote Design Decision						
15	Finish CAD Design						
16	Print 3D Components						
17	Combine Hardware and Shell						
18	Reevaluate and Debug Code						
19	Reevaluate and Debug Wiring						
20	Interim Presentation	All	02/22/22	03/10/22	17	90	3