Home Office System

by

Jackson Clark, Avi Levenson, and Fernando d'Hyver de las Deses de Juillac

Submitted to
the Faculty of the School of Information Technology
in Partial Fulfillment of the Requirements for
the Degree of Bachelor of Science
in Information Technology

Jackson Clark _____ 26th of April 2021
Jackson Clark Date

Avi Levenson _____ 26th of April 2021
Avi Levenson Date

Fernando d'Hyver de Las Deses de Juillac _____ 26th of April 2021
Fernando d'Hyver de las Deses de Juillac Date

Tony Iacobelli _____ 26th of April 2021
Tony Iacobelli, Faculty Advisor Date

University of Cincinnati
College of
Education, Criminal Justice, and Human Services
April 2021

Home Office System

Prepared by

Jackson Clark, Avi Levenson, and Fernando d'Hyver de las Deses de Juillac

Students of
University of Cincinnati
College of Education, Criminal Justice, and Human Services
School of Information Technology
April 2021

TABLE OF CONTENTS

List of Illustrations

TABLES

FIGURES

ABSTRACT

Tens of millions of people use smart devices in their homes providing convenience by using virtual assistants like the Google Assistant, Amazon's Alexa, and Apple's Siri. These assistants are always on and listening for commands to provide the power to turn on your TV, open a recipe, play your favorite music, or start a video chat. However, that functionality to always be on has a security downside in that these devices are listening to everything that happens in the home. Bloomberg reports that Amazon has this private voice data and with the lack of security in most home networks, hackers could too. The Home Office System provides an easy way to turn off all of your smart device microphones at the hardware level in an easy to configure and foolproof way. By giving people the power to easily control their virtual assistants, we can have truly secure, smart homes.

1. Introduction

Project Name: HOS a smart device which takes security to a whole new level.

1.1 Problem Statement:

In an office environment where Google, Alexa and Siri record our conversation(s) on a daily basis we need a way to maintain a level of privacy without worrying about who is listening.

On the google support website they state; there is indeed speech being listened to when the mute button is enabled. According to google "Can Google Assistant unintentionally collect my voice data? What happens if it does and what are my choices? Occasionally, the Assistant will activate when you didn't intend it to, because it incorrectly detected that you wanted its help (like by a noise that sounds like "Hey, Google")"(Data Security). User(s) need a way to keep privacy to themselves rather than having companies knowing everything.

1.2 Solution:

The proposal is to create a hardware device and a mobile application for Android. The following will be done by limiting the smart assistant paired with the webapp and future HOS 2.0 app from logging data. The assistant is able to be turned on or off to completely stop listening. This is different than any other smart assistant because even though the microphone is muted their device still listens. In addition, Internet of things or internet connected devices, also known as IOT will be included in the HOS update. HOS will know how much the system will learn about the user while maintaining the task functionality of everyday devices. The system will utilize the DuckDuckGo private search engine for security and prevention of third party advertisements, interference, and spyware from learning about your personal browsing behaviors. DuckDuckGo is a search engine similar to Google, Yahoo, and Bing with one huge

exception. The search engine does not track your browsing history and has a main focus in privacy within the search engine history.(DuckDuckGo)

1.3 Project Description

The HOS will incorporate a lot of already existing technologies including the very common WIFI technology, as well as a mobile app and smart speaker. The smart speaker will be able to communicate with each individual user similar to any smart assistant; who communicates without the need to log any data. Taking into consideration large crowds and lots of users we are incorporating user voice recognition to re-shape each user's experience in the future. The smart speaker with mobile configuration will be plugged into the wall without the need of a battery allowing for 24/7 use without disruptions. Our personas and focus groups include college students, parents, and business people. The mobile app will enable users to pair each user profile for the device and allow the user to turn on or off the microphone on the device as desired. This will be an everyday smart assistant to assist with daily information needs.

1.4 User Profile

Our users are categorized in four user groups such as family members, college students and anyone who owns a smart assistant already but wants true privacy. They were asked to participate during the development to achieve results needed for our research. This provided the team with insights into specific personas to create key considerations for the product. These chosen participants helped the team ensure accurate target execution based on the needs of our user categories.

USER PROFILE:

PROJECT: Home Office System
POTENTIAL USERS: · Family members concerned with listening devices · College Students · Anyone that owns a Google Home, Siri, Alexa that wants to be more secure

SOFTWARE, INTERFACE, AND RELATED EXPERIENCE:

The primary target user base will include anyone who owns and operates smart assistant devices. With smart assistants becoming more popular, people will naturally seek to be able to utilize these features within the contexts of their own lifestyles. Here are the top key user classes that will be attracted to the features and product that we offer:

College Students: Smart devices are attractive to them. College students usually use smart devices on a regular basis to help them with homework, cooking, and getting directions.

Parents: Parents use smart devices to listen to music and turn on and off lights. They also use it to check the weather and traffic.

TASK EXPERIENCE:

Individuals who own smart devices, such as (Alexa, Google Home, & Siri), will have experience using voice activated devices. Of the defined user groups, most of them, will have experience utilizing mobile application configuration of a physical product.

Individuals using the application will also have experience performing tasks such as:

Searching WIFI devices, pairing devices and searching individual web results as well as some but limited networking setup experience.

FREQUENCY OF USE:

The initial configuration of this product will only need to be performed once but may be continually updated. For our product demonstration and in actual use, the product will be able to connect to a mobile device via WIFI and be able to control the microphone on the device.

At our product demonstration, we will be able to show the use cases to appeal to the different user groups outlined above. Demonstrating limited functions and added features to be in future updates.

KEY PROJECT DESIGN REQUIREMENTS THAT THE PROFILE SUGGESTS:

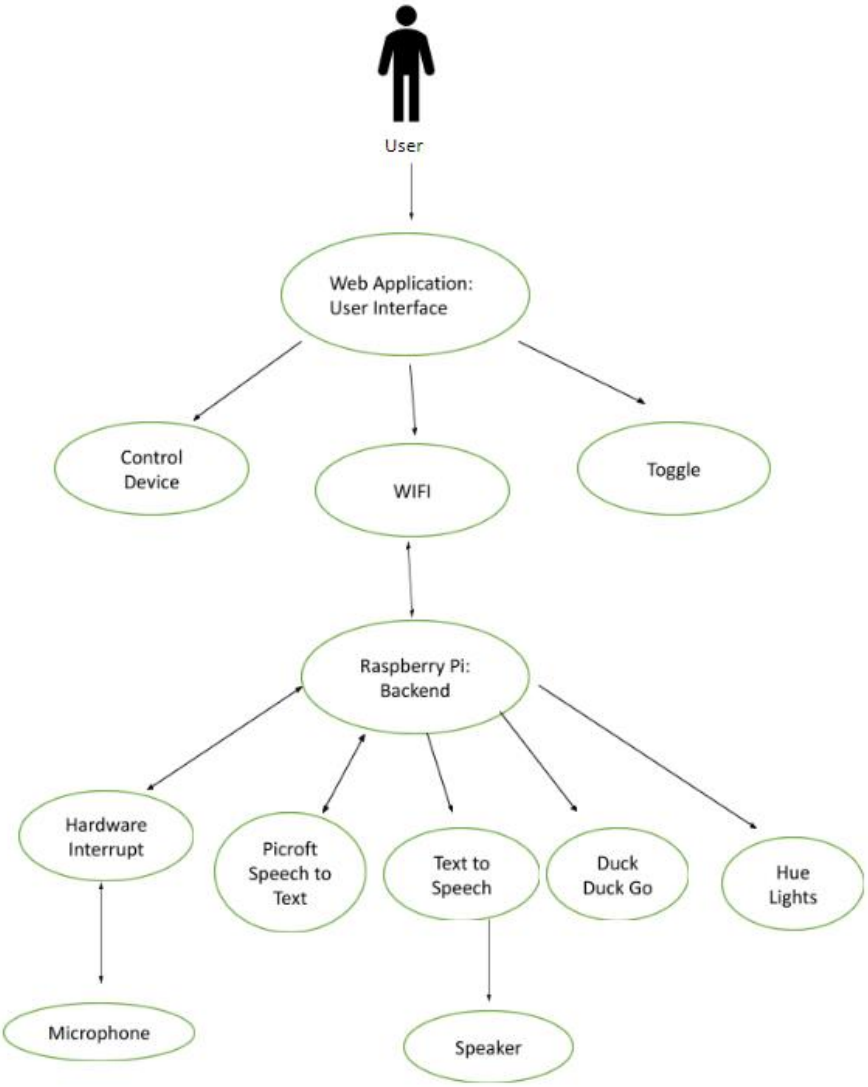
- Visually appealing, clean flow, and easily understood and navigate UI
- Ability to turn features on or off
- Quick setup time

Table 1: User Profile

1.5 Use Case Diagram (refer to Figure 2)

The following diagram shows how the user interacts with the smart assistant via the Raspberry Pi. The raspberry pi functions through WIFI from the mobile app to be able to turn off the microphone completely with a toggle switch. Showing the speech to text process through the Raspberry Pi using the search engine DuckDuckGo to achieve the responses from our smart assistant after reading the text data from DuckDuckGo. Using text to speech to synthesize speech from the text results on the search.

Figure 2: Use Case Diagram



2. Budget

In Table 1 below we will go over our projected cost estimates for the development and implementation of the Home Office System. This is a rough estimate of total cost within a 5 year turnover rate for profit margin. We expect in a 5-year time span to be able to make our money back.

Table 1: Project Budget, portrays the cost estimate for the development and implementation of the Home Office System.

Table 1: Project Budget

Project Name:	Home Office Security (HOS)				**Team #**	17
Project Members:	Jackson Clark, Avi Levenson, and Fernando d'Hyver				**Project Advisor:**	Tony Lacobelli

Problem Statement

In an office environment where Google, Alexa and Siri record our conversation(s) on a daily basis we need a way to maintain a level of privacy without worrying about who is listening.
On the google support website they state that there is indeed speech being listened to when the mute button is enabled. According to google "Can Google Assistant unintentionally collect my voice data? What happens if it does and what are my choices? Occasionally, the Assistant will activate when you didn't intend it to, because it incorrectly detected that you wanted its help (like by a noise that sounds like "Hey, Google")". We need to keep our privacy to ourselves rather than having companies knowing all about us.

Project Description

The HOS or Home Office System is a system that will incorporate a lot of already existing technologies including the very common Bluetooth technology, as well as a mobile app and a smart speaker Azure API. Our smart speaker will be able to communicate with each individual user like any other smart assistant without the need to log any data and or be listening to you all the time. Taking into consideration large crowds and lots of users we are incorporating user voice recognition to shape each user's experience. The smart speaker with mobile configuration will be plugged into the wall without the need of a battery giving the user peace of mind. Our personas and focus groups include college students, parents, and business people. The mobile app will enable users to pair each user profile for the device and allow the user to turn on/off the microphone on the device as desired. This will be an everyday smart assistant to assist with daily information needs.

Project Asset Type

Operational Improvement — Comments: Better sense of privacy

Funding Source (if applicable)

Self — Comments: We are funding the project ourselves.

Risk Identification (See Risk Types tab)

	Risk Rating 1-5 (5 is high)*	*Comments*	*Weight*	*Score*
Work Effort (days)	4		40%	1.60
Complexity	5		60%	3.00

Project Stakeholder(s)

Avi Levenson, Jackson Clark, Fernando Fernando d'Hyver de las Deses de Juillac, and University of Cincinnati

Project Risk Score:				4.60			
Estimate of Benefits							
If project will generate revenue, estimate 1 year here:	$ 700.00						
Select other benefits the project may bring a customer or user:							
Risk Avoidance	1						
Improved customer satisfaction	1						
Increased system availability	1						
Productivity or process improvement	1						
Reduced costs	1						
Estimated Cost Rough Order of Magnitude:							
	Rate Per/Hr	**Work Effort (Hours)**	**1 X Costs**	**Ongoing Annual**			**Comments:**
				Rate Per/Hr	**Work Effort (Hours)**	**1 X Support Cost**	
Labor - IT	20	27	$ 540.00	20		$ -	
Labor - External		18	$ -		0	$ -	
Software - External			$ 25.88				
Hardware - External			$ 435.00				
Misc.							
TOTAL			$ 1,000.88			$ -	
5-Year ROI Analysis							
Description		**5- Year Expected**	**Conservative (1.5)**				
Total Costs		$ 1,000.88	$ 1,501.32				
Total Benefit		$ 3,500.00	$1,750				
Total Costs/Benefit Differential		$ 2,499.12					
Conservative Costs/Benefit Differential		$ 248.68					

2.1 Objectives/Deliverables

Based on our research, only a couple of possible similar options have come to light. The new Iphone IOS update shows an orange light which shows up when the camera can be turned on; when it turns green that means that the camera is turned on and recording, at the right-top corner. Available IOT devices out there do not currently have a hardware solution to turn off power to the microphone. Current systems still require for the mute button to be pressed to mute or unmute the microphone on the device itself rather than on a mobile app.

We are developing a web app and mobile application-based platform for IOT devices. This platform can communicate with hardware in the smart assistant to completely turn off power to the microphone, where it will not be listening in comparison to our competitors. Furthermore, rather than logging personal data we will be using the DuckDuckGo search engine giving users their privacy. The HOS platform prevents companies from taking ownership of personal data or

being worried about personal data being recorded. By combining these features from above we can achieve a smart assistant and IOT device which is worry free.

Other possible solutions in the market do not have the options of no data logging or sending back data to a server option. Current solutions presented by these devices are using hardware toggle switches like the mute button instead of software solutions. All other devices such as Google Assistant, Android phones, Amazon Echo, and Microsoft Cortana products use a Physical/ Software based toggle switch to turn off responses to the user but there's no proof of the device not listening. Our platform will allow users to conserve their privacy by allowing the user to turn off the device's microphone by cutting power to the device via a switch to the hardware.

The H.O.S will also include a Raspberry Pi 3b for the purpose of controlling an electronic switch to cut power to the microphone on the device as desired by the user.

The features of the H.O.S will include:

- Ability to control security settings
- Utilization of software Android application and web app-based toggle switches
- Voice based search engine
- No advertisements
- No data will be stored about the user or their search history

Together, these features will provide users with the worry-free experience they need to feel more secure when talking about private matters without feeling like their IOT devices are listening.

2.2 Project Schedule

Table 2: Project Schedule

The schedule below is the project general overview of what we predict the timeline estimates to be. The timeline was set with realistic expectations knowing how long each task will take to reach completion. The end dates are true to the task assignment end date.

Task Name	Duration (Days)	Start Date	End Date
1. 0 Project Management and Deliverables	232	8/24/20	4/13/21
1.1 Team Building	7	8/24/20	8/24/20
1.2 Ideas and Brainstorming	7	8/24/20	9/7/20
1.3 Fall Semester Assignment 0: Team Members & Project Name	7	8/24/20	8/24/20
1.3.1 Project Name	7	8/24/20	9/2/20
1.3.2 Project Logo and Branding	7	8/26/20	8/31/20
1.4 Fall Semester Assignment 1: Team Contract	14	8/24/20	9/2/20
1.4.1 Project Approval	21	9/1/20	9/14/20
1.4.2 Work Breakdown Structure	14	9/7/20	9/23/20
1.5 Fall Semester Assignment 2: Project Abstract for Tech Expo	21	9/7/20	10/12/20
1.6 Fall Semester Assignment 3: Team Contract Resubmission	7	9/7/20	10/12/20
1.7 Fall Semester Assignment 4: User Profile	14	10/8/20	10/19/20
1.8 Fall Semester Assignment 5: Use Case Diagram	14	10/7/20	10/19/20
1.9 Fall Semester Assignment 6: Draft Report	14	10/21/20	11/9/20
1.10 Fall Semester Assignment 7: Final Fall Semester Report	28	11/4/20	11/30/20
1.11 Fall Semester Oral/virtual Presentation	35	11/4/20	11/30/20
1.11.1 Presentation Practice	45	11/4/20	11/15/20
1.12 Spring Semester Assignment 1: Testing Plan/Report	28	1/08/21	2/10/21
1.13 Spring Semester Assignment 2: Abstract	7	2/10/21	2/17/21
1.14 Spring Semester Assignment 3: Draft Tech Expo Poster	14	2/17/21	3/2/21
1.15 Spring Semester Assignment 4: Final Poster	7	3/2/21	3/9/21
1.16 Spring Semester Oral Presentation	21	3/16/21	4/5/21
1.17 Spring Semester Assignment 5: Final Report	21	3/16/21	4/12/21
1.18 Spring Semester Assignment 6: Safe Assign Final Report	21	3/16/21	4/12/21
1.19 IT Expo	8	4/6/21	4/13/21
1.19.1 IT Expo Exhibit and Preparation	8	4/6/21	4/13/21
1.20 Spring Semester Assignment 7: Final Library Copy	9	4/12/21	4/26/21
2.0 Research	42	7/4/20	9/7/20

2.1 Equipment Requirements	22	9/9/20	10/1/20
2.1.1 Determine type of software	2	9/9/20	9/14/20
2.1.3 Determine type of Raspberry pi	2	9/18/20	9/20/20
2.1.4 Determine type of wires/cables needed	3	9/28/20	10/1/20
2.2 Software Requirements	22	9/9/20	10/1/20
2.2.1 Determine App Language	5	9/9/20	9/14/20
2.2.6 Determine app notification settings	3	9/28/20	10/1/20
2.3.1 Research FCC Standards Compliance	7	10/1/20	10/8/20
2.4 Miscellaneous Research	7	10/14/20	10/21/20
2.4.4 Budget Analysis	7	10/14/20	10/21/20
3.0 Design	21	10/21/20	11/11/20
3.1 Create Prototype	7	10/21/20	10/28/20
3.1.1 Create integrated wiring design	7	10/21/20	10/28/20
3.1.5 Create wireframe Diagrams	7	10/28/20	11/4/20
3.2 Create App Legal Documentation	7	11/4/20	11/11/20
3.2.1 Draft Legal Disclaimers and Privacy Policy	7	11/4/20	11/11/20
4.0 Environment Set-Up	12	9/24/20	10/6/20
4.1 Import Libraries for Development	12	9/24/20	10/6/20
4.2 Setup GitHub	12	9/24/20	10/6/20
4.3 Install Raspberry Pi	12	9/24/20	10/6/20
4.3.1 Set up Raspberry Pi	12	9/24/20	10/6/20
4.3.2 Configure Android version and API	12	9/24/20	10/6/20
4.4.3 Connected devices to relay	12	9/24/20	10/6/20
5.0 Development (Back End and Front End)	123	10/1/20	2/1/21
5.1 Create Layout	14	10/1/20	10/15/20
5.2 Choose Color Scheme	14	10/1/20	10/15/20
5.3 Create Buttons	14	10/8/20	10/22/20
5.3.1 Turn on mic through Wifi	14	10/8/20	10/22/20
5.3.2 Turn off mic through Wifi	14	10/8/20	10/22/20
5.3.3 List Devices	14	10/8/20	10/22/20
5.4 Develop App Features	109	10/15/20	10/1/25
5.4.1 Develop WIFI functionality	26	10/15/20	11/10/20
6.0 Testing	73	2/1/21	4/14/21
6.1 Functionality Test	30	2/1/21	3/2/21
6.1.1 Turn on/off WIFI	30	2/1/21	3/2/21

6.1.4 Voice command functionality	30	2/1/21	3/2/21
6.2 User Pilot Test	30	3/2/21	4/1/21
6.2.1 Select user groups	30	3/2/21	4/1/21
6.2.2 Conduct usability test for phone	30	3/2/21	4/1/21
6.2.3 Perform test on Android Phone	30	3/2/21	4/1/21

3. TECHNICAL ELEMENTS

The following will explain more in depth our networking technologies implemented such as Wi-Fi and its functions. Application section talks more about which platform is used to create the mobile application and how it interacts without networking WIFI technology. The physical hardware design lists and explains the hardware used in the project as a whole to create the HOS smart speaker.

3.1 Network

The networking elements include device to device WIFI communication, Raspberry Pi 3 WIFI connection, Android Mobile Application and Web App. WIFI will also be used to send commands to a Raspberry Pi 3 Wireless module that controls a power relay to the microphones.

3.2 Application

The mobile Application will be built using Android Studio, an integrated development environment (IDE) used for android app development. The mobile application will be created using java programming language. The app will be using WIFI features, as a result, WIFI permissions are required. By enabling these permissions users will effectively be able to discover nearby devices based on their location.

3.3 Physical Hardware Design

The hardware elements of the project include the use of multiple smart devices. The integrated design of the Raspberry Pi 3 include: the microphone module, the microphone switching relay powered by the raspberry pi pinouts, and wired wall adapter eliminating battery needs. The wall adapter will provide the Raspberry Pi 3 with power and the Raspberry Pi will provide power and audio to the peripherals. The Raspberry Pi 3 WIFI module itself will connect to the Wi-Fi. Also, the Raspberry Pi WIFI will communicate with the mobile device used for manual control of the smart speaker microphone.

4. TEST PLAN

4.1 Overview

Two of our test subjects were in the same room as the device and we had two test subjects through zoom. For the test subjects who were on zoom we had Fernando repeating the question as asked by the user(s). For the test subjects who were in the same room we had them speak directly to Ezra. Each user(s) had asked a handful of questions and seeing if the results were as expected or if the response failed based on how they asked the question. We also had each user turn on and off the mic through the apache local IP address website to see if the user(s) got a response through their phone.

4.2 Objective

Our testing strategy is to have repetitive and consistent results according to the prompts asked. We allowed the subjects to ask one question in which we could have multiple unknown results. Therefore, each user asked a foreign question that had no prior context which wasn’t given.

4.3 Test Cases

Here's where we show the responses and functionality of the user's interaction with the assistant and the responses from the system based on the specific task or question asked. The record number is based on the specific user and their interactions with the device.

Figure 3: Test Case

Record #	Test case #	User(s)	Input	Expected output	Actual output	Pass/ Fail	Reason for failure/success	Turning Microphone on/off	Date
1	1A	Joe L.	What is the weather outside?	Should give a weather response.	It gave a weather report.	p	Ezra understands the prompt.	yes	2/6/21
2	1B	Maria D.	Play ABC news?	Should give current US news from ABC.	Current news from Australia.	F	Ezra misunderstood the command.	yes	2/6/21
3	1A	Paul D.	Play number dice?	Should ask for min. and max. range.	Select a number from min. and max. range.	P	Ezra understands this as a game skill.	yes	2/6/21
4	1B	Rob C.	Who is playing in the Super Bowl 55?	Should respond with what teams are playing.	Response gave current teams playing.	P	Ezra can give current sport facts.	yes	2/6/21

Record #	Test case #	User(s)	Input	Expected output	Actual output	Pass/ Fail	Reason for failure/success	Turning Microphone on/off	Date
1	1A	Joe L.	What is the weather?	Should give a current weather response.	It gave a weather report.	p	Ezra understands the prompt.	yes	2/6/21
2	1B	Maria D.	What is the weather?	Should give a current weather response.	It gave a weather report.	P	Ezra understands the prompt.	yes	2/6/21
3	1A	Paul D.	What is the weather?	Should give a current weather response.	It gave a weather report.	P	Ezra understands the prompt.	yes	2/6/21
4	1B	Rob C.	What is the weather?	Should give a current weather response.	It gave a weather report.	P	Ezra understands the prompt.	yes	2/6/21

Record #	Test case #	User(s)	Input	Expected output	Actual output	Pass / Fail	Reason for failure/success	Turning Microphone on/off	Date
1	1A	Joe L.	Tell me the news.	Should give current US news.	Gave current news events from the US.	p	Ezra understands the command	yes	2/6/21
2	1B	Maria D.	Tell me the news.	Should give current US news.	Gave current news events from the US.	P	Ezra understands the command.	yes	2/6/21
3	1A	Paul D.	Tell me the news.	Should give current US news.	Gave current news events from the US.	P	Ezra understands the command	yes	2/6/21

4	1B	Rob C.	Tell me the news.	Should give current US news.	Gave current news events from the US.	P	Ezra understands the command	yes	2/6/21

Record #	Test case #	User(s)	Input	Expected output	Actual output	Pass/ Fail	Reason for failure/success	Turning microphone on/off	Date
1	1A	Joe L.	Who is the President of the United States?	Should give the current President.	It gave the current President of the United States.	p	Ezra understands the prompt.	yes	2/6/21
2	1B	Maria D.	Who is the President of the United States?	Should give the current President. .	It gave the current President of the United States.	P	Ezra understands the prompt.	yes	2/6/21

3	1A	Paul D.	Who is the President of the United States?	Should give the current President.	It gave the current President of the United States.	P	Ezra understands the prompt.	yes	2/6/21
4	1B	Rob C.	Who is the President of the United States?	Should give the current President.	It gave the current President of the United States.	P	Ezra understands the prompt.	yes	2/6/21

5. CONCLUSION

Our Fall Semester 2020 shows our lessons learned throughout the semester and future improvements for the Spring semester. Within Spring Semester 2021 we explain our future plans for the HOS smart speaker.

5.1 Fall Semester 2020

Lessons Learned:

Throughout this project we had faced many obstacles within this first semester. We have gone through a lot of trial and error and a lot of personal discovery. We needed to pay more attention to detail and what was extremely important to our project and to stop sweating the little things. We got stuck on an audio issue, where we could have moved forward with our project. Other issues will arise with condensing the project down, however we feel we will be able to move forward rather quickly and more efficiently.

5.2 Spring Semester 2021

Lesson Learned: In this Spring semester we have learned timeline is everything and staying on task for a deliverable is of utmost importance. Trial and error is not an efficient way to test out functionality but rather do proper research first to ensure functionality the first time. Having multiple weekly meetings with our advisor has helped us. When we encountered obstacles they were taken care of in a timely manner.

ADDITIONAL INFORMATION

The team contacted the following professionals for clarification and additional insight

1. Tony Iacobelli, Instructor/Advisor - University of Cincinnati CECH
2. Rebekah Michael, Lead Instructor - University of Cincinnati CECH

TECHNICAL REFERENCES

Burton. (2018, November 20). *Popular Smart Home Devices Carry Cybersecurity Risk*. Bloomberg Law. https://news.bloomberglaw.com/privacy-and-data-security/popular-smart-home-devices-carry-cybersecurity-risks-1

Data security and privacy on devices that work with Assistant. (2020). Retrieved November 12, 2020, from https://support.google.com/googlenest/answer/7072285?hl=en

DuckDuckGo Privacy. (2020). Retrieved November 10, 2020, from https://duckduckgo.com/privacy

Sarkar, Somrata. "Your Google Home Is Listening to You – Here's Why, and What to Do." *Tech Advisor*, 3 Apr. 2020, www.techadvisor.co.uk/feature/digital-home/is-google-home-listening-me-3695908/