ECE 441 Spring 2021

# WEEK #8 GROUP MEETING LOG

Lab Session: 2

Group Number: 1

Instructor: Dr. Jafar Saniie

Due Date: 10 March 2021

Acknowledgment: I acknowledge all of the work (including figures and codes) belongs to me and/or persons who are referenced.


Member 1: Cameron Haley

Member 2: Anthony Bañuelos

Member 3: Colin Prochnow

Member 4: Kamil Kaczmarczyk

# Smart Music Display

Project Goal:

A Bluetooth smart speaker/mirror with a detailed, music-centric GUI for a richer listening experience

Standards used in Project:

*Bluetooth, IEEE 802.11, I2C*

System Constraints:

- Cost
  - Size and resolution of monitor, had to use what was on-hand
  - Using two-way film and glass instead of a two-way mirror

- Power Requirement
  - The power supply we chose delivers 24V@3A, which provides 72W of power.
  - Raspberry Pi 4B requires 5V@3A, which makes 15W
  - The two speakers each should be supplied ideally with around 30W each.
  - The LEDs require 5V@up to 9A depending on the current color selected and brightness level

- Efficiency
  - Any audio processing we do needs to be real-time, as LED synchronization depends on this

- Size
  - Has to be big enough to house the two 4” speakers and a computer monitor
  - Has to be small (and light) enough to hang on a wall comfortably

Prior Knowledge Acquired Critical to Design Project:

ECE 100, ECE 211, ECE 213, ECE 218, ECE 242, ECE 307, ECE 308, ECE 311, ECE 319, ECE 449

CS 104, CS 115, CS 116, CS 330, CS 331, CS 350, CS 351, CS 425, CS 458

*Highlight related course number in yellow and describe relevance.*

ECE 211, 213 - Circuit design; there are a few basic circuit design components in our system.

ECE 308 - We will be processing audio signals to drive LEDs along to the music. This requires frequency domain representation (e.g. FFT), which is a major topic of the class.

CS 331 - We will use many data structures and algorithms to implement the logic we desire; efficiency was a topic of the class and is also very important for how we handle the state, audio processing, and data storage aspects of our application.

CS 425 - At some point we may opt for using a relational database for storing information.

CS 458 - Information security is very important to a personal device such as this.

# Meeting 1

| | |
|---|---|
| Date | Sunday, 14 March 2021 |
| Start Time | 21:00 |
| Duration | 2 hours |
| Attendance | Everyone |

## 1. Agenda

During this meeting we discussed some of our previous work on the project, shared what progress we were able to make since our last meeting, and we began developing new material and components for our project. A lot of time during this meeting was dedicated toward LED control as there were some issues that arose.

Alexa Voice Services - Cameron

Alexa was successfully installed and built on the Raspberry Pi using their SampleApp:

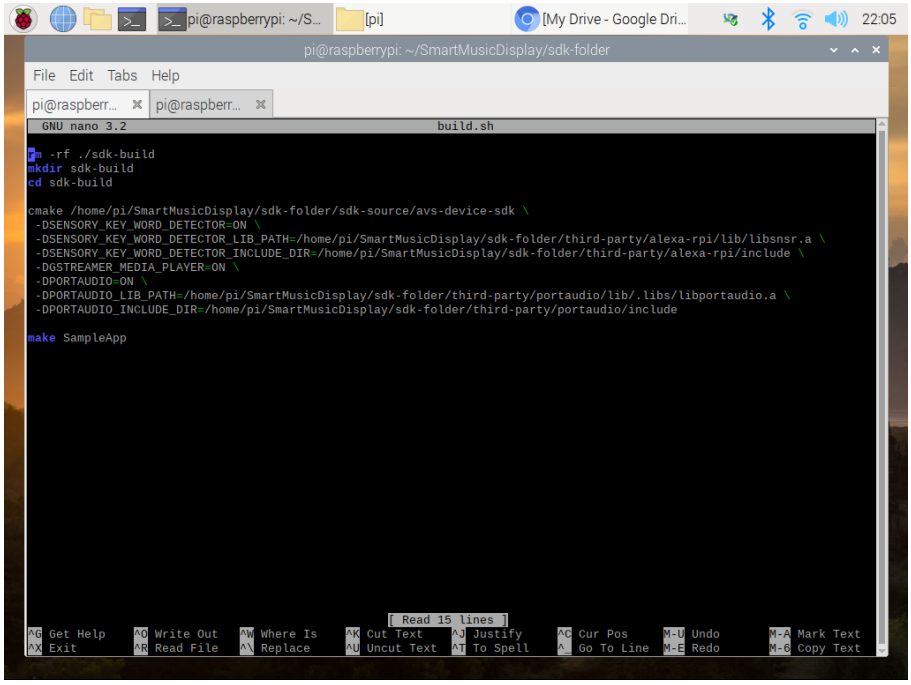


*Figure 1 - Custom script to build the AVS SDK*

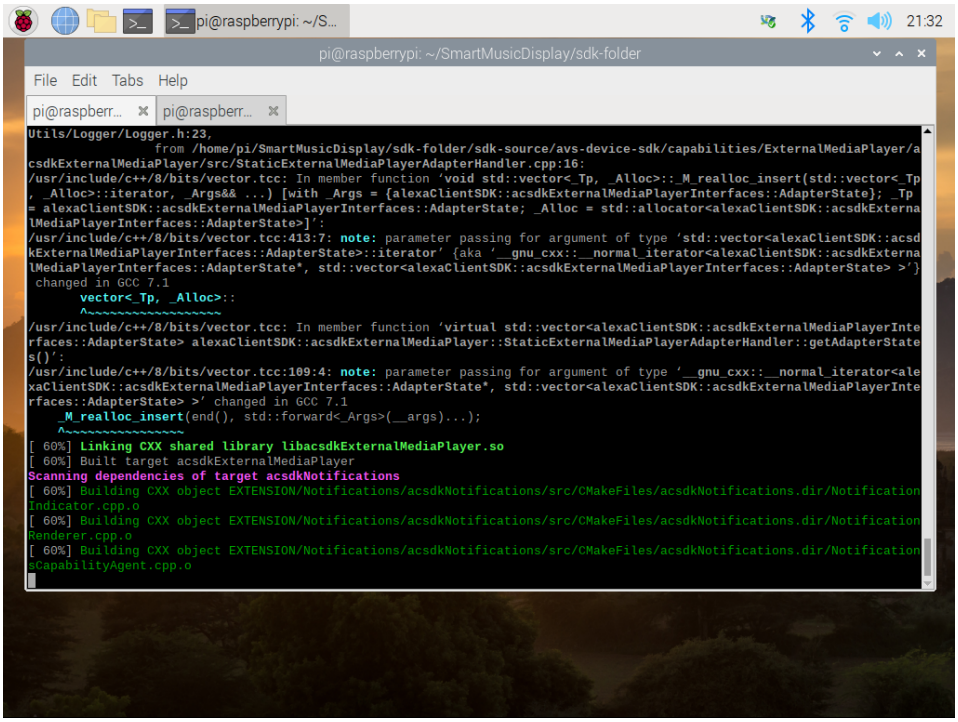


*Figure 2 - Building the AVS SDK*

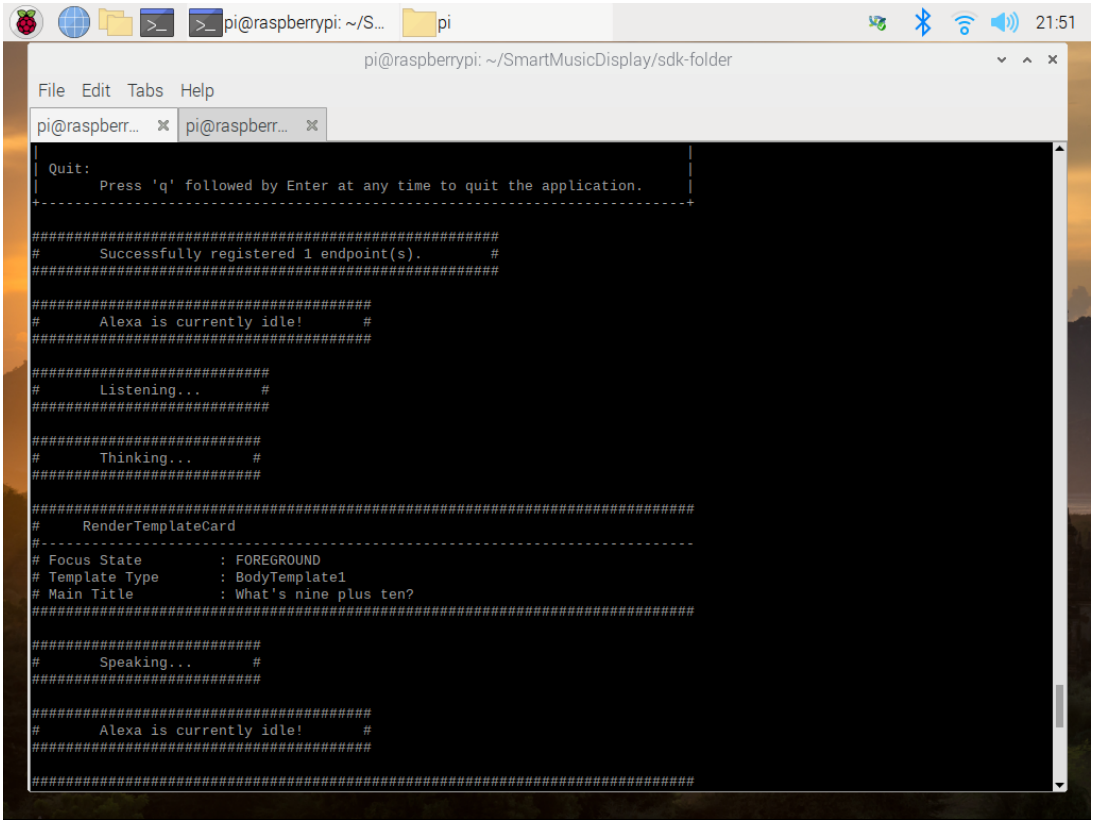


*Figure 3 - Alexa answering to a voice command*

As demonstrated in **Figure 3**, Alexa successfully heard a question asked through our USB microphone, and answered it through the speakers. This is only the first step; from here, we need to add and modify the SDK to do various things. During the meeting (and in the past) we did research on the following three key features we would like to implement:

Bluetooth Music Control

The goal here is to control Bluetooth music via voice commands, such as "Alexa, pause the music". To do this, one must enable certain Bluetooth CMake parameters. We attempted to enable those parameters during our meeting, but unfortunately audio output stopped working when AVS was built with those parameters, indicating possible conflicts between our previous Bluetooth work and AVS. This will be investigated further in the future, as it currently takes about 30 minutes to rebuild everything so there was not sufficient time for testing.

Component Control

We would also like to control states of components on our device (LEDs on/off, brightness, etc.). This can be done using Smart Home for AVS, which allows us to use various controllers:

- **Alexa.PowerControlle**r (on/off)
- **Alexa.RangeController** (brightness)
- **Alexa.ModeController** (type of LED synchronization)

This will be looked into after successful Bluetooth control, as it is not as crucial to having a successful prototype.

Login With Amazon

For a fully fleshed out product, we need a way for users to link their own account. This is known as Login With Amazon (LWA) and will most likely be done (in our case) through Code Based Linking.

LED Control - Colin and Anthony

We went through the process of testing the LEDs to get the basic controls back which was originally done the first time in the lab. However, we have been encountering some major issues during the testing.

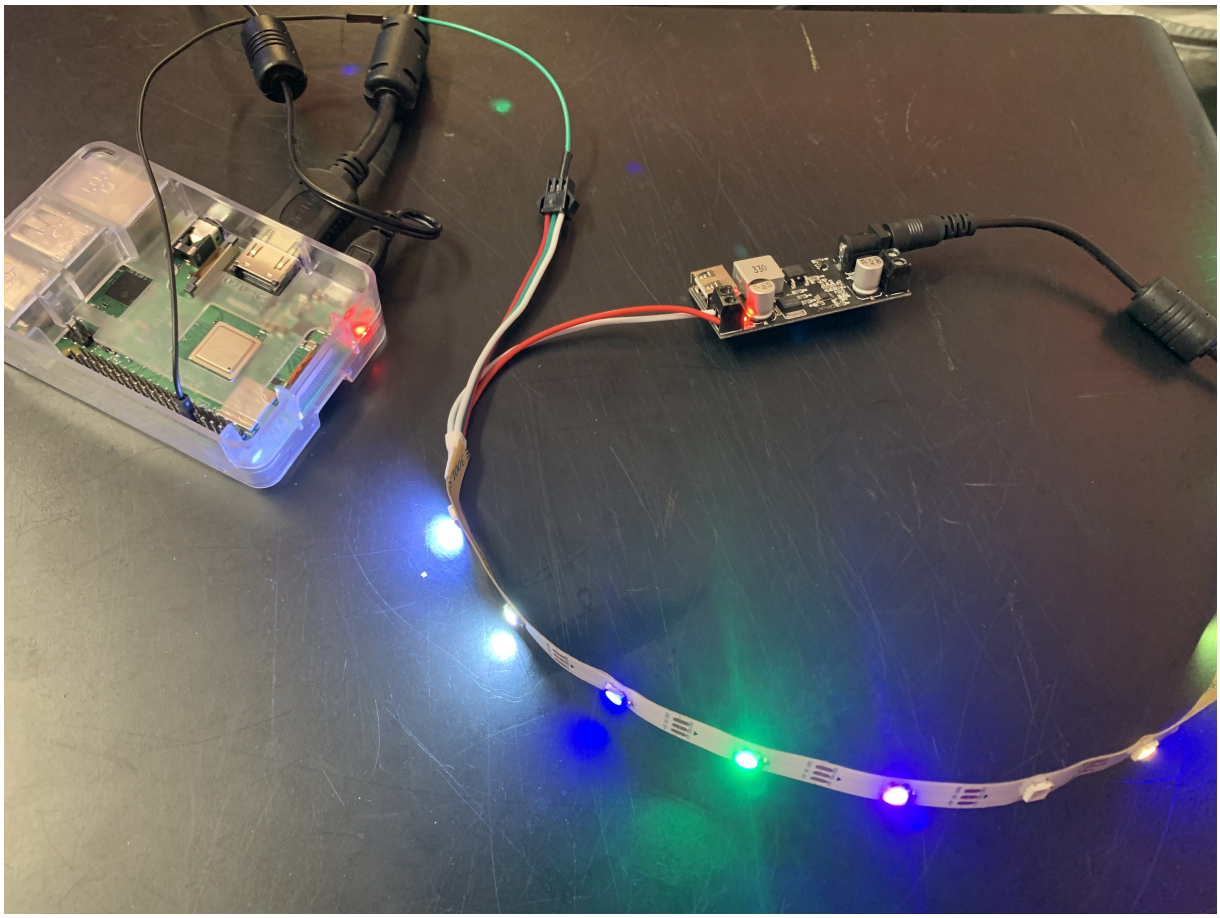

*Figure 4 - Current setup of the LED control*

For example, the image above is when we tried loading in all 150 LEDs with the color Red. We found that the current is lower than expected and that the voltage is consistent throughout the LEDs at 5V so the issue is currently unsure and the troubleshooting will go on and try to be fixed by the next meeting. We found that potential problems could reside in the power supply, code, raspberry pi being out of date, etc.

Sensor and Weather Data - Kamil

Our BME280 sensor is fully functional. The sensor was soldered and correctly connected to the raspberry PI, In addition, we created a python script to be able to read the information from the sensor. Now we have a way to measure the temperature,pressure and humidity in the room. The following pictures show the BME280 sensor working with the python script to output the data.

*Figure 5 - Configuration of the sensor attached to a secondary Raspberry Pi for testing*

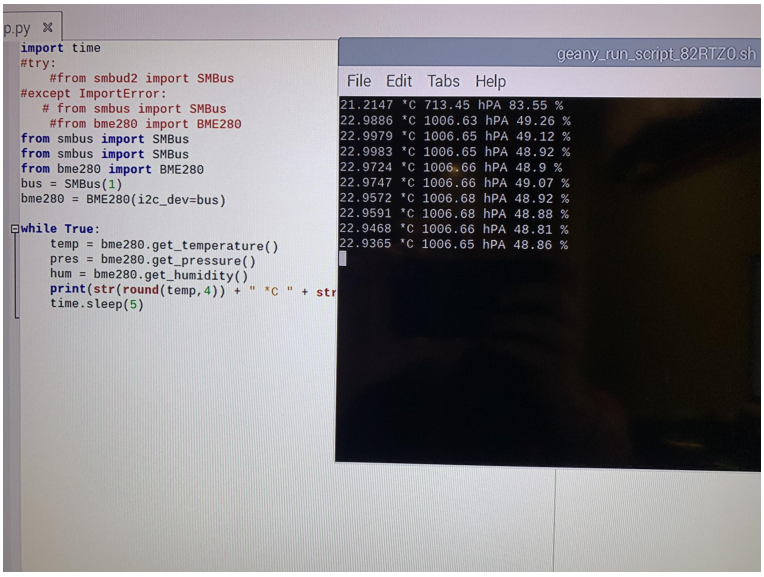


*Figure 6 - Code Required to extract data from the sensor, along with sample outputs*

## 2. Tasks and Work Distribution

**<u>Cameron Haley</u>**

- Alexa, UI
    - Initial implementation
    - Further development and integration with Bluetooth in later meetings

**<u>Anthony Banuelos</u>**

- LEDs
    - Referencing back on initial testing of LEDs during lab
    - Exploring power supply options considering the power supply we currently have does not supply enough current with 150 LEDS
        - Look into reducing the number of LEDs that are on the strip
        - Would need to know more concrete measurements related to the enclosure design

**<u>Colin Prochnow</u>**

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**Kamil Kaczmarczyk**

- Sensors
    - Investigation and development of code that will allow our sensors to function
    - Investigation into API which will allow for similar data that can be recorded from our sensors, but pulled from the Internet to provide metrics related to the outside environment

## 3. Progress and Milestones

| Milestone | Tasks | Assigned To | Date |
|---|---|---|---|
| **1 - Development** | | | |
| 1.1 | Order all parts | Everyone | 20 Feb |
| 1.2 | Test out all the parts, ensure they work | Everyone | 27 Feb |
| 1.3 | Circuit designed | Cameron Haley | 2 Mar |
| 1.4 | Basic LED control | Colin Prochnow | 7 Mar |
| 1.5 | Basic sensor information | Kamil Kaczmarczyk | 14 Mar |
| 1.6 | Bluetooth connectivity and information working | Anthony Banuelos<br>Colin Prochnow | 14 Mar |
| 1.7 | Design enclosure | Cameron Haley<br>Kamil Kaczmarczyk | 16 Mar |
| 1.8 | Speakers and Amplifier working and playing audio from the RPi | Cameron Haley | 21 Mar |
| 1.9 | Bluetooth pair via NFC; how and is it feasible? | Kamil Kaczmarczyk | 21 Mar |
| 1.10 | Bluetooth real-time audio processing | Anthony Banuelos<br>Colin Prochnow | 28 Mar |
| 1.11 | Use external API/library to get live weather data | Kamil Kaczmarczyk | 28 Mar |
| 1.12 | Able to pass Bluetooth information from Python to Electron | Anthony Banuelos<br>Colin Prochnow | 30 Mar |

| | | | |
|---|---|---|---|
| 1.13 | Synchronize LEDs with music | Anthony Banuelos<br>Colin Prochnow | 4 Apr |
| 1.14 | Enclosure assembled | Everyone | 4 Apr |
| 1.15 | Basic AVS integration | Cameron Haley | 4 Apr |
| 1.16 | GUI built | Cameron Haley | 11 Apr |
| **1.17** | **Integration Test** | **Everyone** | **18 Apr** |

## 4. Next Steps

Further developments will be made with Alexa. Ideally, we will have full integration into our systems. As it stands now, we will be replacing the current Bluetooth implementation with BlueAlsa with control from Alexa. If we are unable to implement Bluetooth controls to the level that we would like with Alexa, we may switch back to using BlueAlsa and continue our work with that. Additionally, we will most likely have to look into purchasing an additional power supply as the current one does not supply enough power for all 150 LEDs. If we are to reduce the number of LEDs, then the amount of current that is required to power the LEDs would decrease, and it is likely that we will not use all of the LEDs in our implementation, but we will not know exactly how many LEDs will be used once we firm up some of the details of our enclosure design. These details may be discussed in future meetings.

# Meeting 2

| | |
|---|---|
| Date | Tuesday, 10 March 2021 |
| Start Time | 15:15 |
| Duration | 2 hours |
| Attendance | All attended |

## 1. Agenda

Updating Meeting Notes

We first updated our meeting notes to incorporate the new template design. This took a significant portion of the meeting, as looking up the classes, figuring out the constraints we've placed on ourselves, etc. took a while. However, in the future this should benefit us and we look to continue making progress on our project in the next meeting.

Power Consumption

It is important that we highlighted the issue of the power supply when talking throughout the whole system. This is a constraint that we addressed while going through the title sheet and we found that this issue may be present throughout the project as we start to compile the parts all together. This may limit our LEDs to a certain brightness, dampen our audio, etc given a power supply that is rated at a certain wattage, in our case, 72W. Although this is not something that we will know until the parts are fully compiled. It is possible that we may need an additional power supply in order to power the LEDs, but this will be determined once we integrate all of the components together toward the end of the project.

Timeline Updates

Finally, we discussed the timeline during the time we had left. Specifically, we discussed what tasks were falling behind, what the issues were, and what tasks we should add on. The enclosure design was originally due today, but it was pushed back because we decided that Alexa integration takes priority over building an enclosure. Thus, a new due date of March 30th was set, and the Enclosure Assembled task was pushed back likewise. Additionally, the LEDs have proven to be a little sporadic, as discussed in the prior meeting, so the due date for this was readjusted as well for this weekend. Finally, we are looking into incorporating an API to show a live weather map in your area. We still have to decide if this falls into the scope of our project, as it is mainly a music display, and decidedly distinct from a smart mirror. However, if we decide to move forward with it, we could use this API to provide current, future, and historical weather maps.

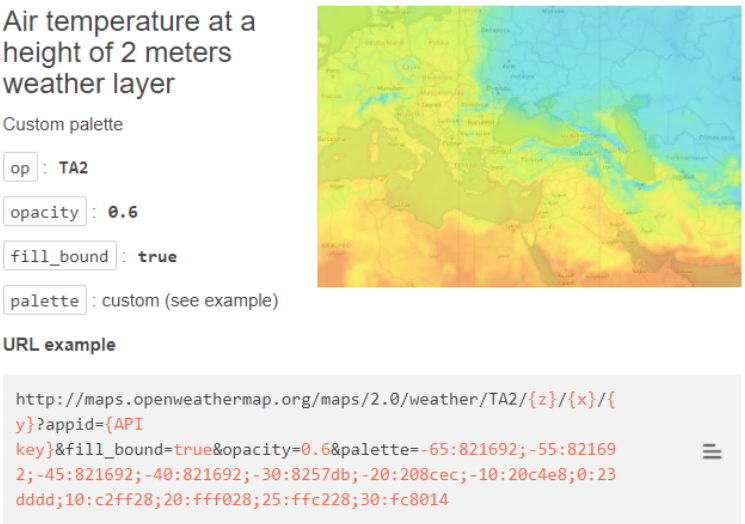


*Figure 7 - API capability of retrieving weather map data that could be incorporated onto the device*

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## 4. Next Steps

Once the issues related to the LEDs can be resolved, some more research can be conducted related to controlling the audio in response to music. Some preliminary research yields resources such as:

https://dropsofai.com/understanding-audio-data-fourier-transform-fft-and-spectrogram-features-for-a-speech-recognition-system/

Which makes use of Fourier Transform (specifically Fast Fourier Transform) but more research will have to be conducted related to the connection between Bluetooth audio and real time processing of it, instead of reading in an audio file like is done in the link. Development of Alexa and finalization of the enclosure design are among immediate areas that will be developed in the upcoming week during the next two meetings.