Functional Specification

Year: 2023 Semester: Spring Team: 18 Project: RDNT

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Assignment Evaluation:

| **Item** | **Score (0-5)** | **Weight** | **Points** | **Notes** |
| --- | --- | --- | --- | --- |
| **Assignment-Specific Items** | | | | |
| **Functional Description** |  | x3 |  |  |
| **Theory of Operation** |  | x3 |  |  |
| **Expected Usage Case** |  | x3 |  |  |
| **Design Constraints** |  | x3 |  |  |
| **Writing-Specific Items** | | | | |
| **Spelling and Grammar** |  | x2 |  |  |
| **Formatting and Citations** |  | x1 |  |  |
| **Figures and Graphs** |  | x2 |  |  |
| **Technical Writing Style** |  | x3 |  |  |
| **Total Score** |  | | |  |

5: Excellent 4: Good 3: Acceptable 2: Poor 1: Very Poor 0: Not attempted

General Comments:

1.0 Functional Description

Our device will be able to interface with different addressable LEDs. We will build a diffused acrylic LED display but our device itself will be able to connect to any compatible LED device. Our device will have 3 modes. Mode 1 will accept audio input from a bluetooth device. Mode 2 will accept audio input through 3.5mm AUX-in from a compatible device. Mode 3 will use the onboard microphone to pick up audio. No matter the mode used, our device will display a lightshow on connected addressable LED strips. The lightshow will associate colors to frequencies and be modular for use with a customizable amount of LEDs. Our device will also feature a 3.5mm AUX-out for connection to external speakers. This allows the user to still be able to listen to the music when in Mode 1 and Mode 2. We will release an associated app that can be used to pick color ranges and initialize connections to LEDs.

2.0 Theory of Operation

Fast Fourier Transform is an algorithm that can be used to isolate frequencies. The algorithm uses Discrete Fourier Transform to find the frequencies that make up a given audio input wave. The frequencies that we want to isolate will correspond to common percussion instruments. This algorithm is O(Nlogn) instead of O(N^2) which will make it faster to compute on our microcontroller by reducing computations for known values.

3.0 Expected Usage Case

The expected usage case is inside of a room in the customer’s home. The device itself will be portable but the diffused acrylic LED display will be difficult to transport. However, our device will be modular so it can be transported independently of the original LED display and connected to another compatible LED display. Only one person will be able to connect to the device and play their own music at a time, but the output of the music will be visible and audible to anyone in the room. We expect our users to be college aged if they use the device in their homes. Another possible usage case is a restaurant or bar where the user will be the store’s manager using the device to create a lightshow for their guests.

4.0 Design Constraints

Needs to be usable with compatible LEDs. This means our current driver will need to draw a variable amount of current based on the amount of LEDs connected.

We must be able to synchronize LED’s with an audio stream processed by the microcontroller.

4.1 Computational Constraints

Computational constraints for our project consist of receiving an input of audio stream, through means which can be switched between an AUX input, Bluetooth audio, or a microphone. Computing Fast Fourier Transforms will require the most headroom, since it is the most calculation heavy. We will then use the isolated frequencies calculated by the Fourier transforms to drive the LEDs, and these commands will also require computation done by the microcontroller.

4.2 Electronics Constraints

We expect to need a separate ADC. This separate module will allow us to read greater differences in audio input voltages. Therefore, we will be able to parse greater detail in our audio inputs. Our project will include a diffused acrylic LED display that will be driven by a current driver circuit. We will use a bluetooth module on our microcontroller. We will also feature external controls that will be used to switch the mode and turn our device on and off. There will also be output to 3.5mm AUX-out so that the user can attach their own speakers.

4.3 Thermal/Power Constraints

The biggest concern will be driving the LEDs, as well as any heat output produced by them. Depending on how we design the housing for the LED’s, they could also prove to be a large source of heat. We will try to keep our device room temperature but the LEDs will probably heat up slightly when powered on.

Other sources of heat could be attributed to our power supply wall plug.

4.4 Mechanical Constraints

Our main device will be contained in a small box designed to fit to the size of our PCB, along with any peripheral I/O. This will be the main “device”, while the LED’s fixtures will be of variable amounts, with each fixture being about 1.5 ft tall, and around 3-4 inches length and width-wise. We are still deliberating on the idea of built-in speakers versus separate speakers to play audio, which could increase the footprint of our device as a whole.

4.5 Economic Constraints

The biggest cost will be to create the LED display, as we plan to buy hundreds of individual LEDs. Our project will be around 100 dollars for the device and around 200 dollars for the LED display.

4.6 Other Constraints

5.0 Sources Cited:

