Sound Level Management System

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Table 1 Document Revision History

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Reason For Revision</th>
<th>Change(s)</th>
</tr>
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<tr>
<td>1</td>
<td>11/20/2017</td>
<td>Rough Draft</td>
<td></td>
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<tr>
<td>2</td>
<td>12/04/2017</td>
<td>Final Draft</td>
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1 Introduction

High sound levels can be detrimental to a person's hearing, and should not be allowed in public places. Keeping noises within expectable levels should be the requirement of those using the sound devices. Hearing can be damaged whenever music reaches around the 85 decibel level, especially if subjected to this volume for lengths of time. A device that monitors and adjusts volumes to be within safe ranges can help companies keep their client's health at the forefront of their business, and allow for a better environment.

The Jorgensen YMCA holds group exercises in their gym that entail large groups of people working out on the gym floor with music from a speaker system playing in the background. There is a running track located on a catwalk that runs around the outer edge of the gym floor that creates a lot of traffic through the area. The music can cause problems for these customers due to the sound level, and can be very disruptive when using the track during the group exercises. After quite a few complaints from people, the Jorgensen YMCA is looking for a solution that will keep the sound level within safe ranges.

2 Problem Statement

The music that is currently being played during the Jorgensen YMCA's group exercises is causing problems for other YMCA Members and some of the Group exercisers due to the volume. This project focuses on a way to monitor and automatically adjust the sound level of the music in order to keep it within safe levels.

2.1 Literature Survey

2.1.1 SPL Meter

App intended to provide a professional-grade sound level meter from a mobile device equipped with a microphone. This app includes ANSI A and C weighting filters, where A weighting rolls off low frequencies steeply, and C weighting rolls off only slightly. It allows has fast and slow sampling rate and ranges from 40 dB to 120 dB.


2.1.2 Yacker Tracker

Electronic device that signals when the detected sound level is too high based on scale. A simple device that sample the sound pressure of a room, converts it into dB levels and lights up the color of light (red, yellow, green) that the dB level falls into.

http://www.yackertracker.com
2.1.3 Extech SL130W

A sound level monitor with flashing LEDs to alert a user to undesired sound levels. This device allows the user to set maximum and minimum dB levels that they would like to be alerted of.

http://www.extech.com/SL130W/

2.1.4 Room EQ Wizard

Room acoustics analysis software for measuring and analyzing room and loudspeaker responses including sound level. This tool can generate audio test signals and use the results to create analysis graphs.

https://www.roomeqwizard.com/

2.1.5 ANOMS - AIRPORT NOISE MONITORING AND MANAGEMENT SYSTEM

An airport sound level monitoring system that monitors the sound level of arriving and departing aircraft and then creates models with the data received to determine the environmental impact of the surrounding areas.


2.1.6 Bouncy Balls Website

This website monitors sound level and converts it into the movement of some balls that appear in the web browser. It also alerts the user when the input volume is too loud. This is mainly for use in classrooms to ensure that the students are staying quiet.

https://bouncyballs.org/classroommanagement

2.1.7 Conclusions

All the devices above monitor the dB level of a room and report to users through alerts or analysis graphs. Our device will expand on this idea and manipulate the sound level directly after detecting high volumes, while still signaling to the users these high volumes. This means that our device must receive, manipulate, and send audio files from the user’s audio device to the sound system.

2.2 State Customer Need(s)

Define Customers and Customer Needs.
2.2.1 Internal Customers

YMCA: Want their customers to be happy and to provide a low cost, reliable product according to their set constraints

Group Exercise Instructors: an easy to use product that doesn’t get in the way of their instruction

YMCA Group Exercise Customers: must be able to hear the music and have it loud enough to enjoy during the workout

YMCA Regular Customers: Be able to use the surrounding area without too much disruption from the sound system used in the group exercise

2.2.2 External Customers

There are no External Customers

2.3 Define Use Case(s)

Group Exercise Instructor: The instructor should be the only normal operators of the device, their interaction with the device will be to move the device, turn on the device, connect to the device via blue tooth or aux cable, and utilize the device during group exercises.

2.4 System Boundary

Group exercise leader->Our System->sound system

![System Boundary Diagram]

The group exercise leader will connect to the device and send an audio file to it that will be adjusted by the device if necessary and then sent to the sound system.

audio->Our System
Figure 2 System Boundary 02

Our system will be monitoring for audio put out by the sound system and any other sound volumes in the area.

2.5 Interface Requirements and Definition

The Device must maintain a simple interface that allows ease of use, with minimal extra features. There will be an on/off switch and a Decibel level indicator.

2.6 State Customer-Defined Constraints

2.6.1 Cost

The device must cost less than $1000 dollars as a hard cap, but is advised to keep it under $500 dollars.

2.6.2 Interface

The device must be easy to use and understand, with an indicator for the decibel level, connections for auxiliary cable and bluetooth, and an on/off switch.

2.6.3 Wiring

The device cannot use any long wires that may interfere with the group exercise.

2.7 Requirements and Specifications

2.7.1 Cost

All material must cost less than $500 dollars.

2.7.2 Interface

The device will have no more than 3 switches and simple indication LEDs.

2.7.3 Wiring

The device will be connected to external parts through WIFI or Bluetooth.
3 Detailed Design

3.1 Product Design Map

Here is the decomposition of the Sound Level Management device’s design, the detailed list of all of the FRs and PSs is located in appendix A at the end of this document.

Figure 3 Decomposition

Figure 4 FR1
Sound Level Management System 3  DETAILED DESIGN

Figure 7 FR12-FR123

Figure 8 FR121-FR1213
Sound Level Management System

3 DETAILED DESIGN

Figure 9 FR122-FR1224
3.2 Conceptual Design Alternatives

Here are the Pugh matrices for the functional requirements that had multiple solutions. These are ranked on a scale ranking each criteria from 1-3 where 3 is the best and 1 is the worst. The total marked in green is the solution that was selected:

<table>
<thead>
<tr>
<th>Auxiliary</th>
<th>Cost</th>
<th>DC pins</th>
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<tbody>
<tr>
<td>3.5mm Stereo headphone jack</td>
<td>0.95</td>
<td>5</td>
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<tr>
<td>3.5mm Breakout board</td>
<td>1.09</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5mm Stereo headphone jack</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.5mm Breakout board</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 11 Solutions for FR1152
3.3 Design Alternatives Solution

• FR1152: Auxiliary

The 3.5mm Stereo Headphone Jack was chosen here since the breakout board requires too many DC pins and is unnecessary for this application
• FR1151: Blue-tooth
The 4.0 USB transceiver was chosen because there is only one USB port on the chosen board.

• FR1: Micro-controllers
The MKR Zero was chosen instead of the Arduino Zero since the Arduino Zero had some unnecessary feature and the MKR has just the right amount to work correctly in the design

• FR1213: WIFI
Here a USB WIFI was chosen that is not listed since it allows for simple paired connection between two ports

• FR1211: Sound Sensor
The I2S Digital Microphone was chosen due to its ability to immediately convert the sound wave into a digital stream, allowing it to be easily manipulated and transmitted to the main board. It also has a high sensitivity and a max dB limit.

3.4 Risk Mitigation

The main risks are that parts will be incompatible, the audio file will be corrupted, or that sound pressure to decibel level computations will be inaccurate. In order to mitigate these risks the selected components have very simple universal connections that allow them to be easily added to the design, the audio file will be minimally adjusted while passing through or device, and the dB computations will be tested against the 1910.95 Osha Standards which detail the allowed levels of sound pressure in the workplace.

4 Component Definition and Planned Build

Here is a graphic of the whole system:

The system consists of a main board and an external microphone, which will communicate with each other through WiFi, with the external microphone sending a digital sound wave stream to the main board for computations and analysis. The main board will also be interacting with the "external user" who are the group exercise leaders in this case, and the sound system. The external user can communicate with the device through either Bluetooth or auxiliary cable, sending an audio file through either medium. The device communicates with the sound system through an auxiliary cable converted to whatever media cable the sound system takes. This cord will be used for the transmission of the modified audio file.
5 Building Process: Prototype

The building process of the physical prototype and its sound evaluation software was primarily done by Jacob Scheitlin while the sound adjusting software was primarily done by Alan Hess. The prototyping began by first connecting the microphone to the Arduino MKRZero board for I2S communication, then connecting the potentiometer selected to be used for user control to one of the Arduino MKRZero analog ports. The Arduino MKRZero board was programmed in order for it to interpret the information it received from both of these parts.

During the prototyping, it was discovered that the parts selected for communication between the Arduino MKRZero and the external systems of the audio source, sound system, and external microphone system would be more difficult to implement due to compatibility issues in hardware and software. Due to this, the prototype developed uses the built in serial communication library to send the results of the prototypes calculations to a computer running a MATLAB program that plays an audio file and changes its volume based on the results it receives from the prototype.
6 Test Plan

Here is the design FMEA where the severity, occurrence rate, and detectability are ranked from 1 to 10 where 1 represents the best case scenario and 10 the worst case scenario for each criteria. The Risk Priority Number (RPN) is the multiple of the values in each criteria and ranks each failure according to its impact on the design:

Table 2 Design FMEA

<table>
<thead>
<tr>
<th>FRs</th>
<th>Component Failure</th>
<th>Severity</th>
<th>Occurrence Rate</th>
<th>Detectability</th>
<th>RPN</th>
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<tbody>
<tr>
<td>FR112, FR113</td>
<td>Failure to Power</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>8</td>
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<tr>
<td>FR1151, FR1152, FR1153</td>
<td>Failure to Send/Receive Sound File</td>
<td>6</td>
<td>1</td>
<td>6</td>
<td>36</td>
</tr>
<tr>
<td>FR1154</td>
<td>Failure to turn On/Off</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>FR1155</td>
<td>Failure to Adjust</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>FR1211</td>
<td>Failure to Detect Sound Pressure</td>
<td>10</td>
<td>1</td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td>FR1212, FR1213</td>
<td>Failure to Send Data</td>
<td>10</td>
<td>1</td>
<td>6</td>
<td>60</td>
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<tr>
<td>FR1221- FR1224</td>
<td>Failure to Det. Correct dB SPL</td>
<td>9</td>
<td>1</td>
<td>6</td>
<td>54</td>
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<tr>
<td>FR1231</td>
<td>Failure to Correctly Adjust Sound File</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>40</td>
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<tr>
<td>FR1232- FR1234</td>
<td>Failure to Indicate to User</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

6.1 Test Procedure and Results

Here are the FRs from the decomposition that were testing and analysis:

FR1153: Select components capable of sending a sound file to an external sound system

- Make sure the sent file isn’t noticeably corrupted in any way, possibly saving the original file to compare with for testing purposes
- Ensuring the music plays correctly when outputted to the sound system

FR1211: Use components capable of measuring sound pressure
• Using a known dB level, ensure that the bought device can correctly read the dB value
• This will be done using ANSI dB standards

FR1212: Select methods of sending a digital signal to the micro-controller directly

• Since the data sent cannot be corrupted or delayed it is important that the transmitter is tested to ensure no loss
• Run a few known file through the transmitter and compare to the output on the receiver’s side

FR1221: Determine what the sound pressure is in dB

• Using a digital sound wave with a known dB level, correctly implement a code that converts it to the dB level

FR1222: Determine if the sound pressure is above 85 dB

• Ensure that the program is capable of detecting high sound levels by running a sound wave with high points at known locations and having the code save these high data points

FR1223: Determine if the average sound pressure level is above 85 dB for over 15 seconds

• Create a sound file with certain areas of high dB and ensure that the code correctly evaluates these areas

FR1224: Determine if the sound pressure stays within 3dB of a user defined target decibel level in 15 second increments

• Using multiple different user defined dB values, ensure that the code is capable of correcting the sound level on a sound file to keep it within the value’s range

FR1231: Develop a method of adjusting a sound file’s volume

• Ensure that our code is capable of manipulating an audio files volume without corrupting the data within by comparing the input audio file with the output audio file

FR1232: Develop a system of indicating to the user the current sound pressure level

• Using known dB levels, ensure that the device lights the correct bars at each level of sound
6.2 Full System Testing and Analysis

Finally, the system will be tested at the YMCA gym using the speaker system that the device is meant to be implemented on. During these tests the device will keep a record of what the microphone is picking up and when the volume is changed. Allowing for a look at what dB level is being read and how the device is reacting to the readings. During these tests the sound system will be producing known dB level to ensure that the dB reading on the device is correct.

6.3 Test Conclusions

Due to the issues with data transfer between our prototype and the external systems, the prototype could not be fully tested at the YMCA. However, testing of our prototype in a mock situation using a computer running MATLAB showed as a proof of concept that our device worked. Further work and analysis is required in order to achieve all of the goals desired. This would be done by improving the quality of the calculations done on the data, fixing the issues with data transfer between the device and external systems through physical solutions, and by using a multi-core processor instead of a single-core processor for increased computational efficiency and more accurate real-time operations done. Future recommendations for this device is to use a multi core device capable of taking inputs over a minimum range of 5V for ease of data transfer with the external systems and use of either wireless communication boards or the use of wireless USB antenas with a device capable of being the master device for a USB device.

7 Data/Measurements obtained and Calculation/Analysis

FR1153: Select components capable of sending a sound file to an external sound system

• **Results:** Serial communication evaluated to pass in our prototype for sending data.

• **Conclusions:** Works for communication between it and a computer, but needs reevaluation upon implementation of other methods of sending sound files

FR1211: Use components capable of measuring sound pressure

• **Results:** The microphone detected the sound pressure and output a digital sound wave to the main system that will be converted to dB

• **Conclusions:** Needs comparison with professional dB reader for verification that the digital signal meets ANSI dB standards after conversion to dB

FR1212: Select methods of sending a digital signal to the micro-controller directly

• **Results:** Data transmission through the serial port showed no signs of corruption
• **Conclusions:** Works for communication between it and a computer, but testing of the audio file transmission needs to be done for other forms of transmission

FR1221: Determine what the sound pressure is in dB

• **Results:** Conversion of the digital sound wave to a dB level gave a dB level within 2-4 dB of the dB level given on a separate dB level reader at multiple sound levels in real time

• **Conclusions:** Further improvements on the program could be done to make the conversion more accurate given a non-visual method of comparison

FR1222: Determine if the sound pressure is above 85 dB

• **Results:** The program had the correct response while the prototype was exposed to sound pressures above and below 85 dB

• **Conclusions:** No changes are needed for the foreseeable future

FR1223: Determine if the average sound pressure level is above 85 dB for over 15 seconds

• **Results:** The program run evaluated the sound correctly according to a target dB level variable input and a defined dB level constant of 85 dB

• **Conclusions:** Further refinement of the code may improve the evaluation

FR1224: Determine if the sound pressure stays within 3 dB of a user defined target decibel level in 15 second increments

• **Results:** The program appropriately increased/decreased the sound file output if the sound evaluation program’s result is negative/positive. For negative results, an issue could occur that returned a value that would overamplify the sound file output

• **Conclusions:** Further changes to the program is required to ensure the sound file output is within 3 dB of the user defined target decibel level after each sound file change

FR1231: Develop a method of adjusting a sound file’s volume

• **Results:** The program was able to correct the sound level on the audio file output

• **Conclusions:** Works for communication between it and a computer, but needs to be retested for each new form of audio file volume adjustment

FR1232: Develop a system of indicating to the user the current sound pressure level

• **Results:** The prototype outputs the correct value across the 4 pins controlling the barlight given a dB level

• **Conclusions:** The prototype must be retested after the lights are soldered to the prototype for verification that the lights are connected properly
8 Cost

8.1 Bill of Materials

- 2 X MKR Zero :21.90
  https://store.arduino.cc/usa/arduino – mkrzero

- MKR PROTO LARGE SHIELD: 7.95
  https://store.arduino.cc/usa/mkr – proto – large – shield

- 2 X ICS43432 I2S DIGITAL MICROPHONE: 15.94
  https://store.arduino.cc/usa/ics43432 – i2s – digital – microphone

- 2 x HLMP-2820: 3.75

- HLMP-2620: 4.8

- HLMP-2720: 5.64

- Decoder CD74HCT154M96 : 0.77

- 4 x AND SN74LS08N : 0.63

- Bluetooth BLED112-V1: 10.45

- Antena ANTUSB-M: 20.68

- Potentiometer PTA6043-2015CPB103: 1.6
• Breadboard-Friendly 3.5mm Stereo Headphone Jack: 0.95
  https://www.adafruit.com/product/1699?gclid=EAIaIQobChMIvq7QqfaE1wIVwkCGCh3EqAQBwE

• USB AU-Y1005-2: 0.70

• 2x Lithium Ion Polymer Battery - 3.7v 1200mAh: 9.95
  https://www.adafruit.com/product/258

• : 5.62

### 8.2 Cost Analysis

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<tr>
<th>Item</th>
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<th>amount</th>
<th>Total Cost</th>
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<tbody>
<tr>
<td>MKR Zero</td>
<td>Micro-controller</td>
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<td>$43.80</td>
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<tr>
<td>MKR PROTO Shield</td>
<td>Expands Board</td>
<td>1</td>
<td>$7.95</td>
</tr>
<tr>
<td>Digital Microphone</td>
<td>Detects sound waves</td>
<td>2</td>
<td>$31.88</td>
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<tr>
<td>LED Light Bar</td>
<td>Green indicator</td>
<td>2</td>
<td>$7.50</td>
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<tr>
<td>LED Light Bar</td>
<td>Red Indicator</td>
<td>1</td>
<td>$4.80</td>
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<td>LED Light Bar</td>
<td>Yellow Indicator</td>
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<td>$5.64</td>
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<tr>
<td>Decoder</td>
<td>Connects the LED Bars</td>
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<td>$0.77</td>
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<tr>
<td>AND Gates</td>
<td>Connects the LED Bars</td>
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<tr>
<td>Bluetooth</td>
<td>Receives Bluetooth signals</td>
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<td>WIFI</td>
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<td>Potentiometer</td>
<td>Volume level adjustment</td>
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<td>Auxiliary Port</td>
<td>Headphone Jack</td>
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<td>AC/DC Wall Mount</td>
<td>Power Cord</td>
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<td>$5.62</td>
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Total Cost: 164.76

This is the price of all the base parts needed with the exception of the case. On top of this a few additional parts will be purchased as backups to help with testing of parts and the device as a whole. With a maximum budget of 1000 and a suggested budget of less than 500 dollars the build is safely within the budget, as expected.
## 9 Project Plan and Timeline

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<th>Task Name</th>
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<th>Finish</th>
<th>Duration</th>
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<td>9/6/2017</td>
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<td>8/28/2017</td>
<td>9/11/2017</td>
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<td>System Requirements Review</td>
<td>9/4/2017</td>
<td>9/18/2017</td>
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<td>12/8/2017</td>
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<td>1/10/2018</td>
<td>2/21/2018</td>
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<td>2/7/2018</td>
<td>3/7/2018</td>
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<td>Run Tests and Analyze Results</td>
<td>2/21/2018</td>
<td>4/10/2018</td>
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<td>14</td>
<td>Meet with Sponsors and Advisors</td>
<td>3/7/2018</td>
<td>3/21/2018</td>
<td>11d</td>
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Table 4 Project Timeline
10 Evaluation and Recommendations

10.1 Conclusions

The goal of this design is to help mitigate the problem of such intense decibel levels in public areas by adjusting the volume when the device reads high over a 15 second period. This helps create a healthier environment for everyone in the area without disrupting the music too greatly. Unforeseen problems during the building process of this project resulted in the prototype being unable to correctly connect the device to the external systems to send and receive the audio data, and manipulate an audio file’s volume without corrupting the whole file before it is sent to the sound system. This is caused by an inability to test external system connection. However, a working prototype was developed that can be built upon to meet the client’s needs. This prototype uses mat-lab to simulate the audio file to sound system transfer, and the volume adjustment made in between. With use of this simulation the system works as anticipated.

The next steps in this project would be to convert the mat-lab portion into a fully portable system, possibly using another Arduino to process and adjust the audio file throughput. A more robust board than the MKR zero may be necessary in order to achieve this goal. We recommend re-evaluating the required capabilities to adjust an audio file, and ascertain the compatibility of the sound system to the device. This can then be easily integrated into the audio read system we have created.
11 Lessons Learned

- Decomposition of a Project
  I find this to be the most important thing we learned in the first semester of our senior design project. That is, how to split a complex project into simple manageable parts while showing how each part and section is connected to each other and how they form a cohesive device that solves a problem.

- Development of a Simple Micro-Controlled Device
  We learned how to find parts that could connect correctly to our micro-controller while being careful not to run out of available ports on the controller. We also had to use the parts that we needed to have as constraints for what micro-controller needed to be used.

- Computation of Sound Pressure from Sound Waves
  This project is centered on an understanding of sound waves and sound pressure, so we had to learn how to convert a digital sound wave received from a microphone into a dB value that accurately shows the sound pressure.

- Interacting with Clients
  Another big part of Senior Design is the interaction with the client. This helps give a feel for what a contracted engineer client relationship could look like and how to react in these situations.
12 References

- SPL Meter
  http://www.studiosixdigital.com/audiotoolls−modules−2/spl−modules/splmeter.html

- Yacker Tracker
  http://www.yackertracker.com/

- SL130W: Sound Level Alert
  http://www.extech.com/SL130W/

- Room EQ Wizard
  http://www.extech.com/SL130W/

- Airport Noise Monitoring and Management System

- https://bouncyballs.org/classroommanagement
  https://bouncyballs.org/classroommanagement

- Arduino
  https://www.arduino.cc/

- Osha Standards
Appendix A - Design Process Decomposition

Design Decomposition:

FR1: Design and create an affordable sound pressure manager that meets the requirements of the defined use cases

PS1: Micro controller controlled sound level management system

FR11: Design a system that is within the scope of the defined constraints

PS11: Materials Selection

FR12: Design a sound pressure manager that achieves the use case

PS12: Circuit Design/Coding

FR111: Create a design that is within the Budget of 500 dollars

PS111: Inexpensive Electronic Components

FR112: Power the device externally

PS112: 5v, 550 mA bladed outlet to micro USB cord

FR113: Power the device internally

PS113: 3.7v, 1200 mA Li-Po Rechargeable Battery

FR114: Design the device to be portable

PS114: Lightweight Materials

FR115: Allow interfacing with external devices and users

PS115: Input/Output Transmission Components

FR121: Design a system capable of detecting sound pressure

PS121: Sound Sensor connected to the micro-controller

FR122: Design a system capable of evaluating sound pressure

PS122: coding computations from the sound wave

FR123: Design a system capable of responding to sound pressure

PS123: Code that automatically adjusts the audio files volume

FR1151: Receive a sound file from an external device wirelessly

PS1151: USD Blue-tooth Transceiver

FR1152: Receiving a sound file from an external device directly

PS1152: 3.5 mm Auxiliary Cable Port
FR1153: Sending a sound file to an external sound system
PS1153: 3.5 mm Auxiliary cable port
FR1154: Allow users to turn the system ON or OFF
PS1154: Button/Switch
FR1155: Allow the users to enable/disable and adjust a sound pressure level averaging subsystem
PS1155: 3in 10K Ohm Potentiometer
FR1211: Measure sound pressure
PS1211: I2S Serial Bus Digital Microphone
FR1212: Send a digital signal to the micro-controller directly
PS1212: I2S Serial bus connection
FR1213: Send a digital signal to the micro-controller wirelessly
PS1213: 8 channel wireless transceiver operating in the WIFI frequencies
FR1221: Determine what the sound pressure is in dB
PS1221: C++ code that calculates the dB level given a digitally converted value of the sound sensor’s voltage
FR1222: Determine if the sound pressure is above 85 dB
PS1222: C++ code that compares the calculated dB level of PS1221 to 85 dB
FR1223: Determine if the average sound pressure level is above 85 dB for over 15 seconds
PS1223: C++ code that calculates the average dB level in 15 second windows from the sound levels measured in PS1221
FR1224: Determine if the sound pressure stays within 3dB of a user defined target decibel level in 15 second increments
PS1224: C++ code that calculates if the average of the 15 second windows found in PS1223 lies within the user defined dB range
FR1231: Develop a method of adjusting a sound file’s volume
PS1231: C++ code that adjusts the volume of a sound file based on the evaluation of the current sound pressure level
FR1232: Develop a system of indicating to the user the current sound pressure level
PS1232: Multiple LED bars of different colors
FR1233: Develop a system of indicating to the user when the sound pressure level is above 85 dB for over 15 seconds
PS1233: LED Light
14 Appendix B - List of Tables

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16 Appendix D - Proof of Purchase

- Coming Soon!

As of yet nothing has been purchased over the next week or two parts will be ordered for the final design!