UMassAmherst

Team Turn Up

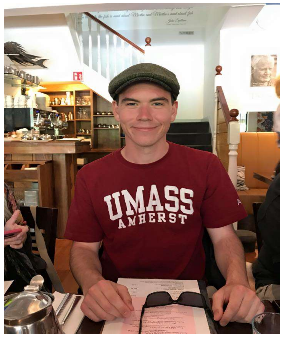
December 4, 2018

Department of Electrical and Computer Engineering

Advisor: Professor Pishro-Nik

Team Members

Nicholas Kafasis
CSE



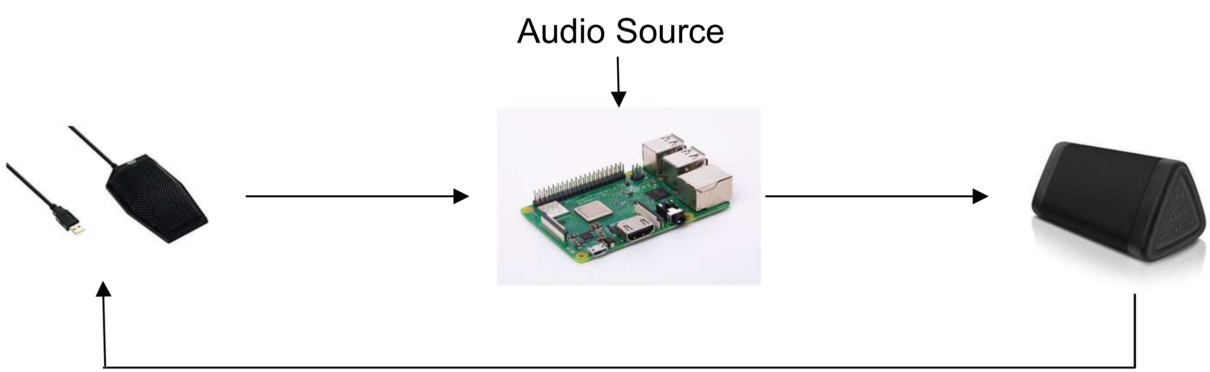
Harold Healy
EE

Ryan Walsh
CSE

Rahaun Perkins
CSE

Problem Statement

- In environments with dynamic noise levels, frequent volume adjustments for Speakers and TVs are a nuisance. Our system will be an intermediary device that regulates the volume of such audio devices based on levels of ambient noise in a room.



Motivations

- Automation is in high demand
  - Temperature
  - Brightness
- Speakers can be found almost anywhere
  - TVs
  - Computers
  - Cars

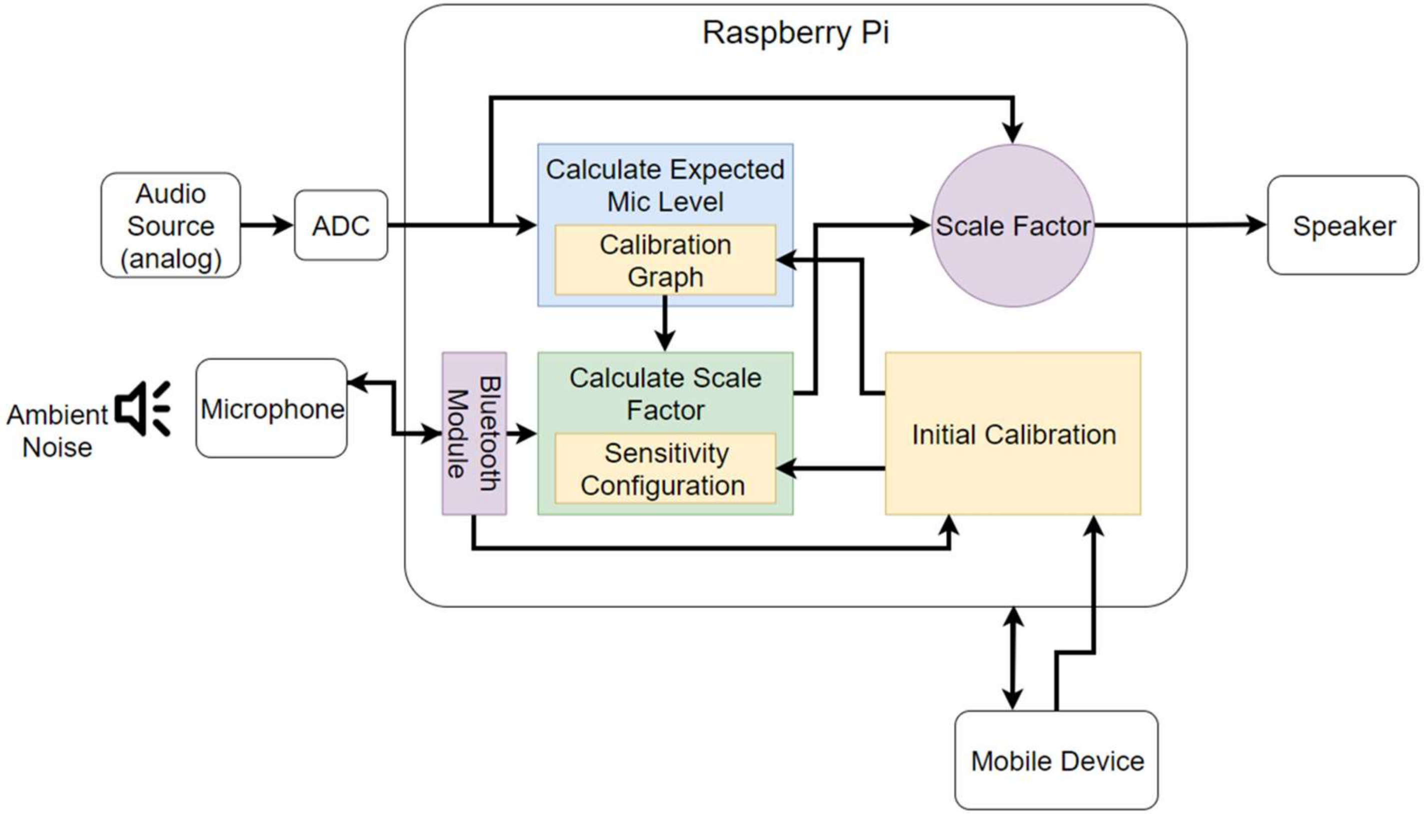
System Requirments

- Easy to use phone app will allow user to set fixed level of audibility above/below ambient noise.
- System will not exceed max volume setting
- System will not react suddenly to isolated loud noises
- System will function in multiple locations within desired room

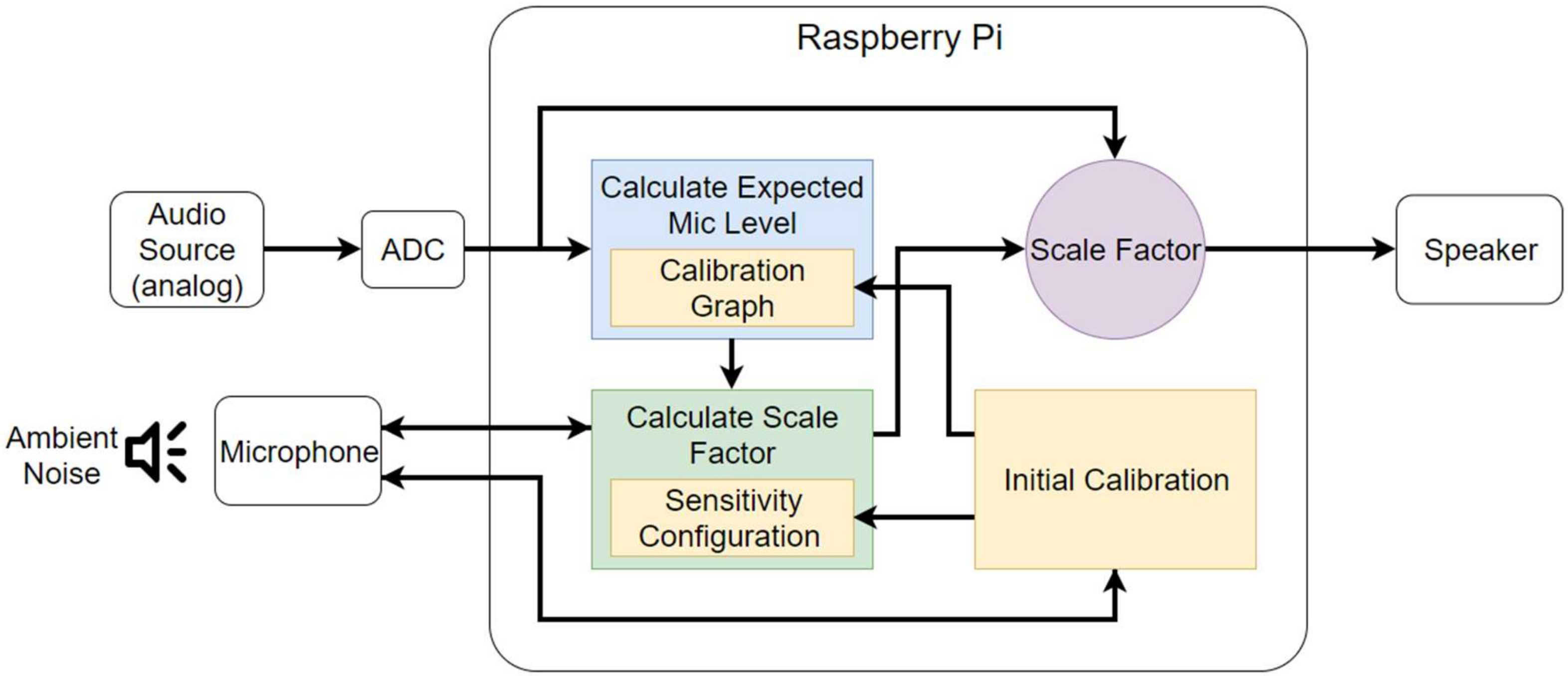
System Specifications

- Maintain signal+noise-to-signal ratio within threshold set by user (range of 1.1-2)
- Reaction time for maintaining ratio is based on sensitivity set by user
  - Moving average weights
    - Low sensitivity: Signal Intensity = [(.001)a + (.999)b]
    - High sensitivity: Signal Intensity = [(.01)a + (.99)b]
      - Where **a** is the intensity of the newest sample set, and **b** is the current value of the moving average.
  - Sample interval of power calculations at 512 samples
- System will work within a 20 ft. radius of microphone

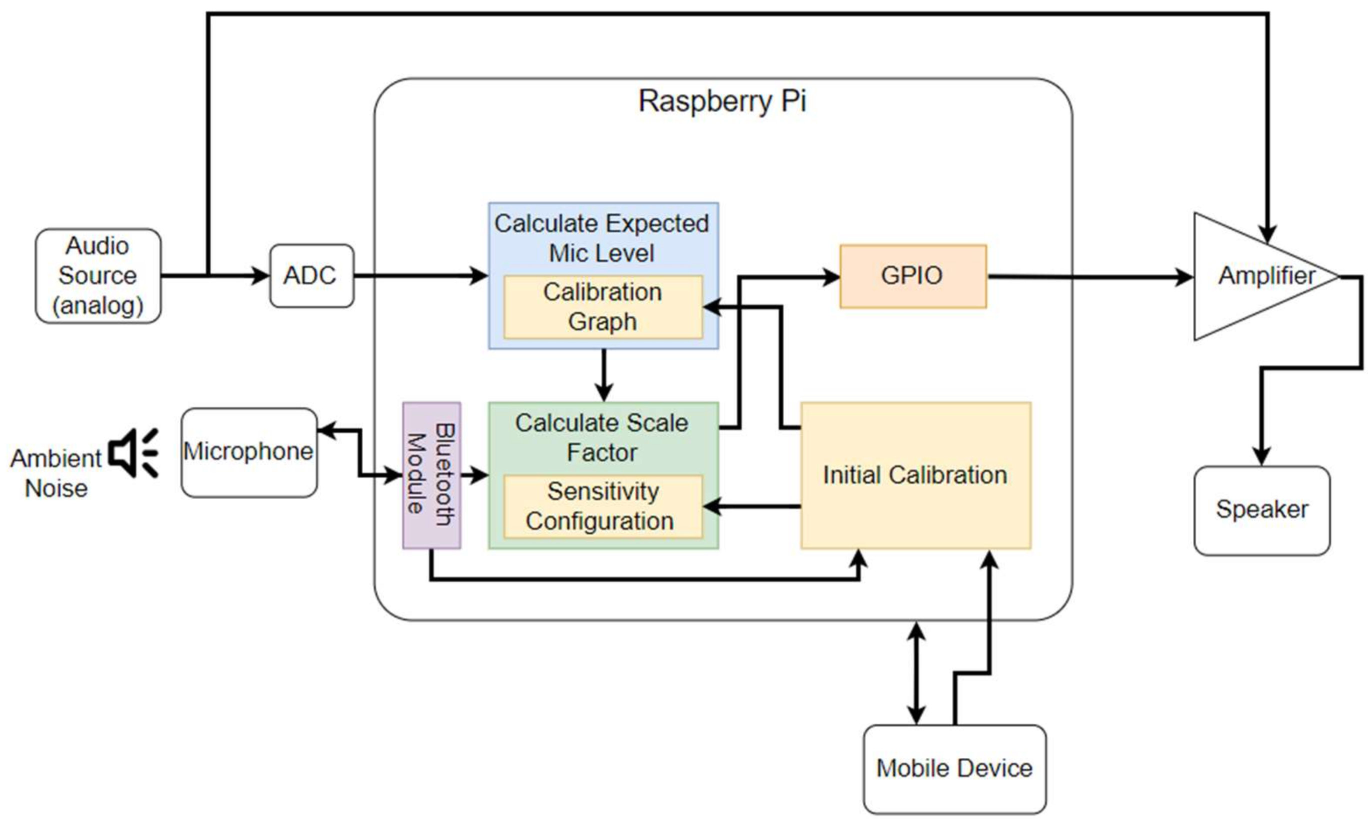
Previous Block Diagram



Current Block Diagram



Proposed CDR Block Diagram



MDR Deliverables

Proposed: No App, Variables will be set manually in code.

Delivered:
Sensitivity:
Weighted Average Constants:

- Average Signal Intensity = [(.01)a + (.99)b]
  - a = avg. of most recent window
  - b = avg. calculated so far
- Calculation Window: 512 samples @44100Hz~ 0.01s

Ratio Threshold: set to 1.5 for MDR Demo purposes

MDR Deliverables

Proposed: Single speaker system

Delivered: Oontz Angle 3

- 10W Peak Output Power
- Lightweight and Portable
- D/A conversion directly on Pi

MDR Deliverables

Proposed: Wired connections

Delivered: Microphone connected directly to Raspberry Pi (MXL-AC404 Conference Microphone)

- 25 ft. range
- 180^{o} range

MDR Deliverables

Proposed: Proof of captured signals and computed calibration graph, additional information graphs

Delivered:

- Calibration graph
- Mic intensity & expected mic intensity over time
- Moving averages of mic intensity & expected mic intensity over time
- Ratio over time
- Scale factor over time

Calibrate.py

Main calibration procedure:

1. Play predetermined calibrate sound
2. Record microphone signal as the sound plays
3. Calculate RMS over the calibrate sound and mic pickup signal
   - RMS taken over 512 samples at a time
4. Obtain model of expected mic pickup intensity as a function of input signal intensity
   - Linear relationship

$$RMS = \sqrt{\frac{x_1^2 + x_2^2 + \ldots + x_N^2}{N}}$$

Listen.py

Main listen procedure:

1. Obtain calibration graph
   - Either run calibration function or load previous calibration graph
2. Play live input signal and record sound from mic
   - Live input signal constantly multiplied by scale factor with default value 1
3. Continuously compute RMS values of input signal and mic signal
   - Compute expected mic intensity with input signal intensity & calibration model

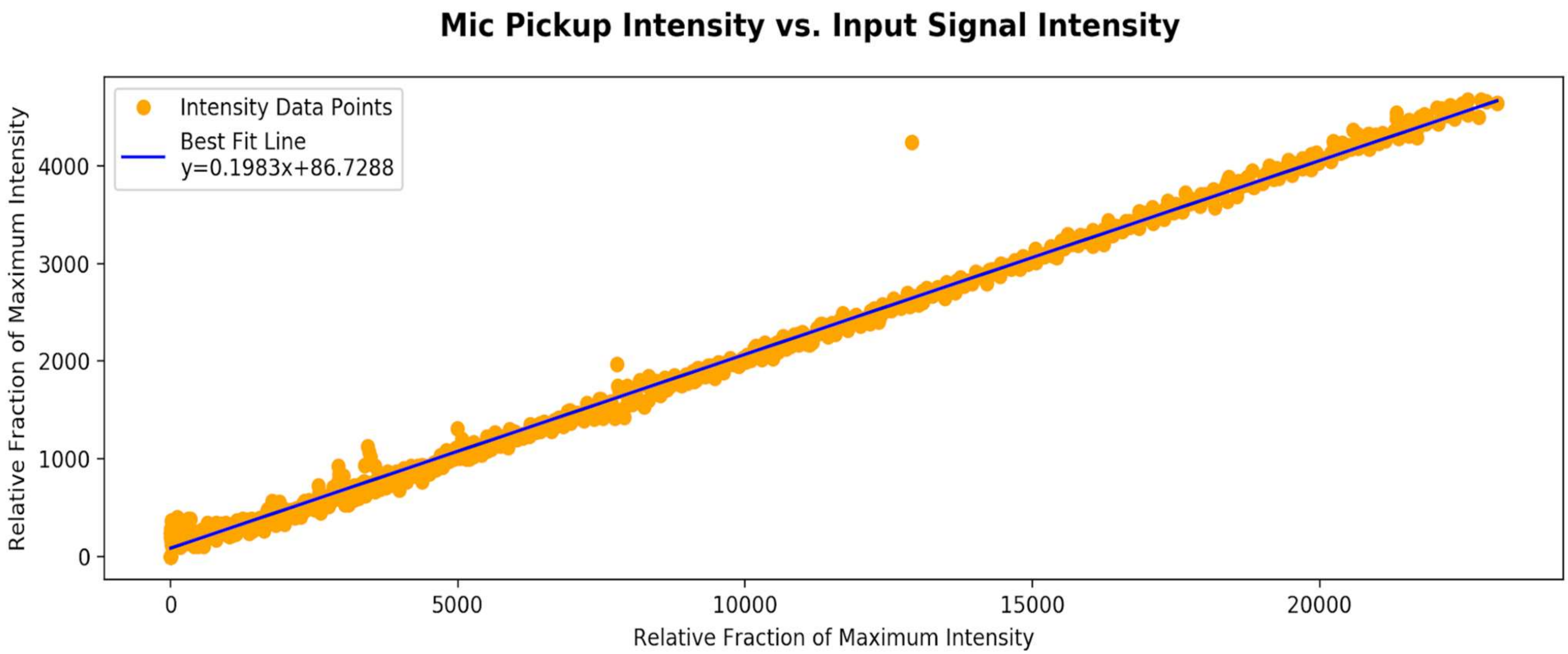
Listen.py

4. Continuously compute the moving averages of mic intensity and expected mic intensity

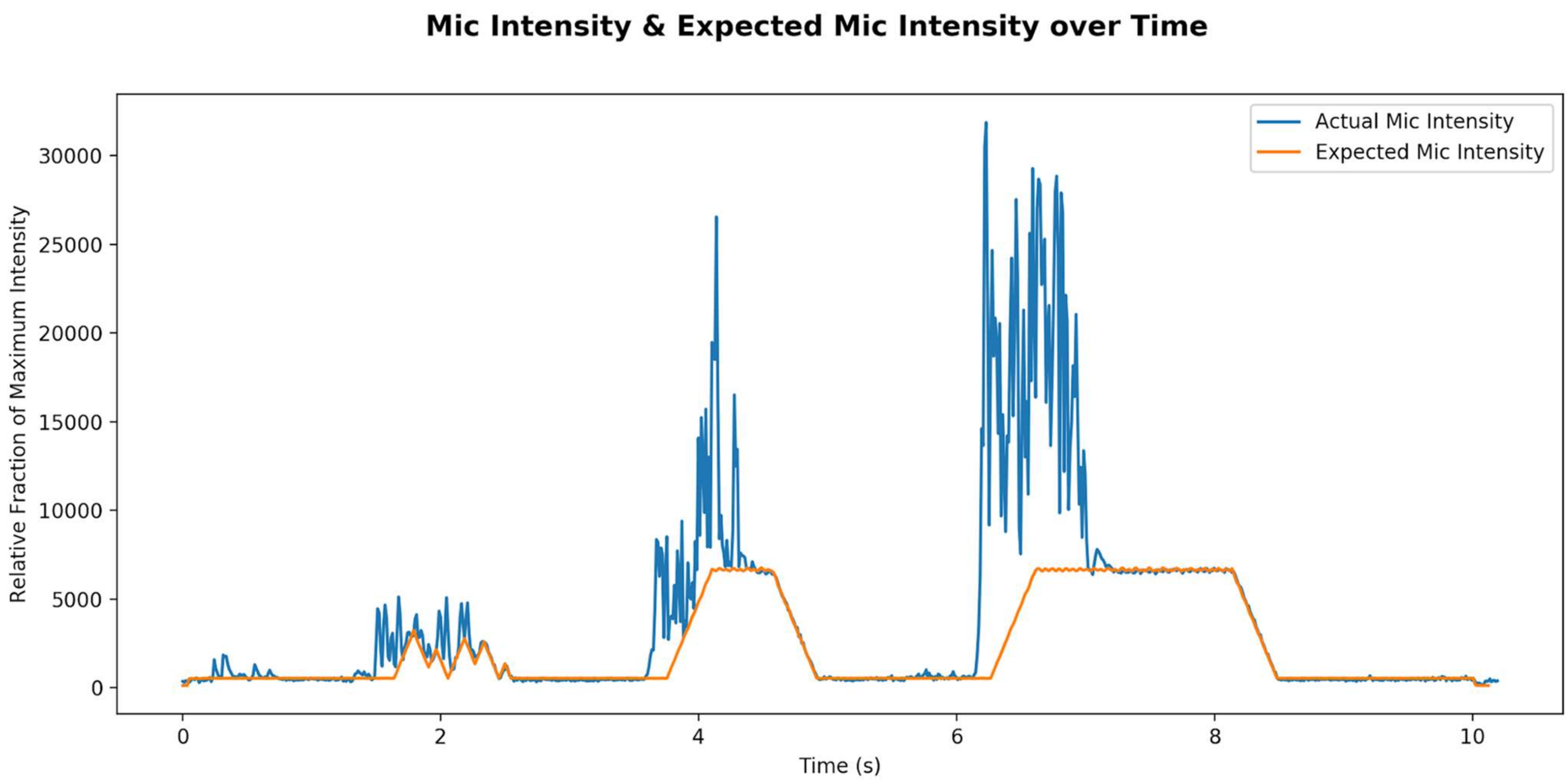
5. Continuously compute ratio of mic intensity average to expected mic intensity average

6. Follow this condition:
   - If: ratio rises above threshold → increase scale factor
   - Otherwise:
     - If: scale is larger than 1 → decrease scale factor
     - Otherwise: keep scale factor at 1

MDR Deliverables: Data Plots - Calibration Graph



MDR Deliverables: Data Plots



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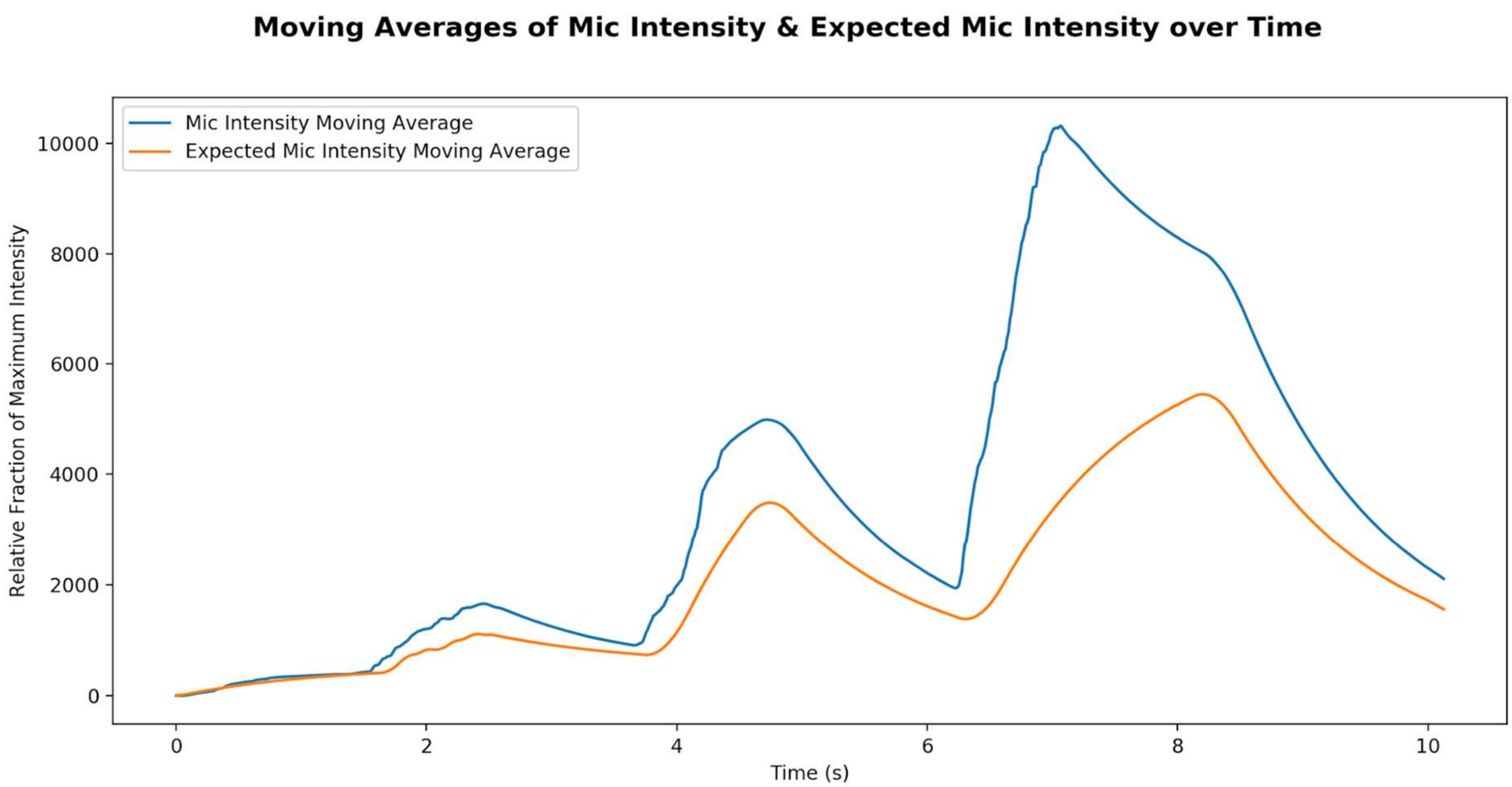
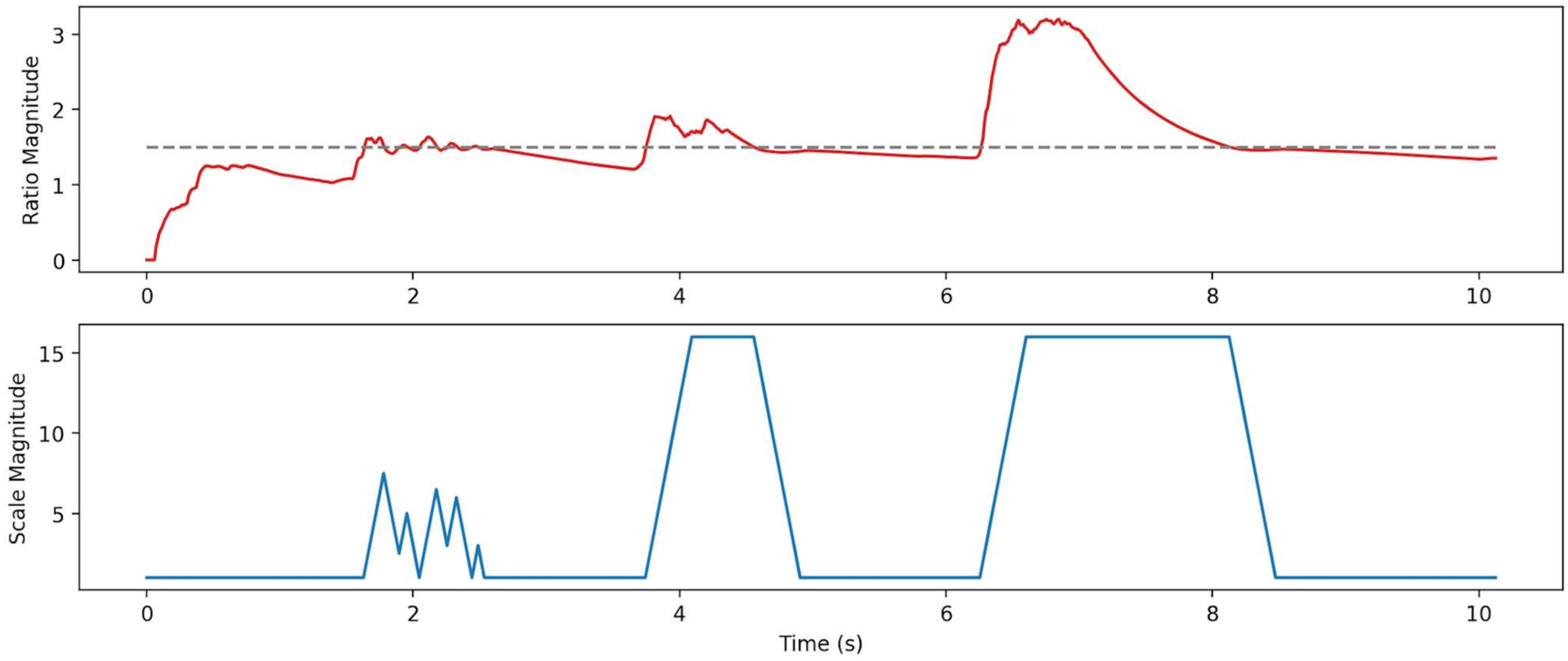
MDR Deliverables: Data Plots



MDR Deliverables: Data Plots

Scale Factor and Avg. Mic Intensity to Avg. Expected Mic Intensity Ratio over Time



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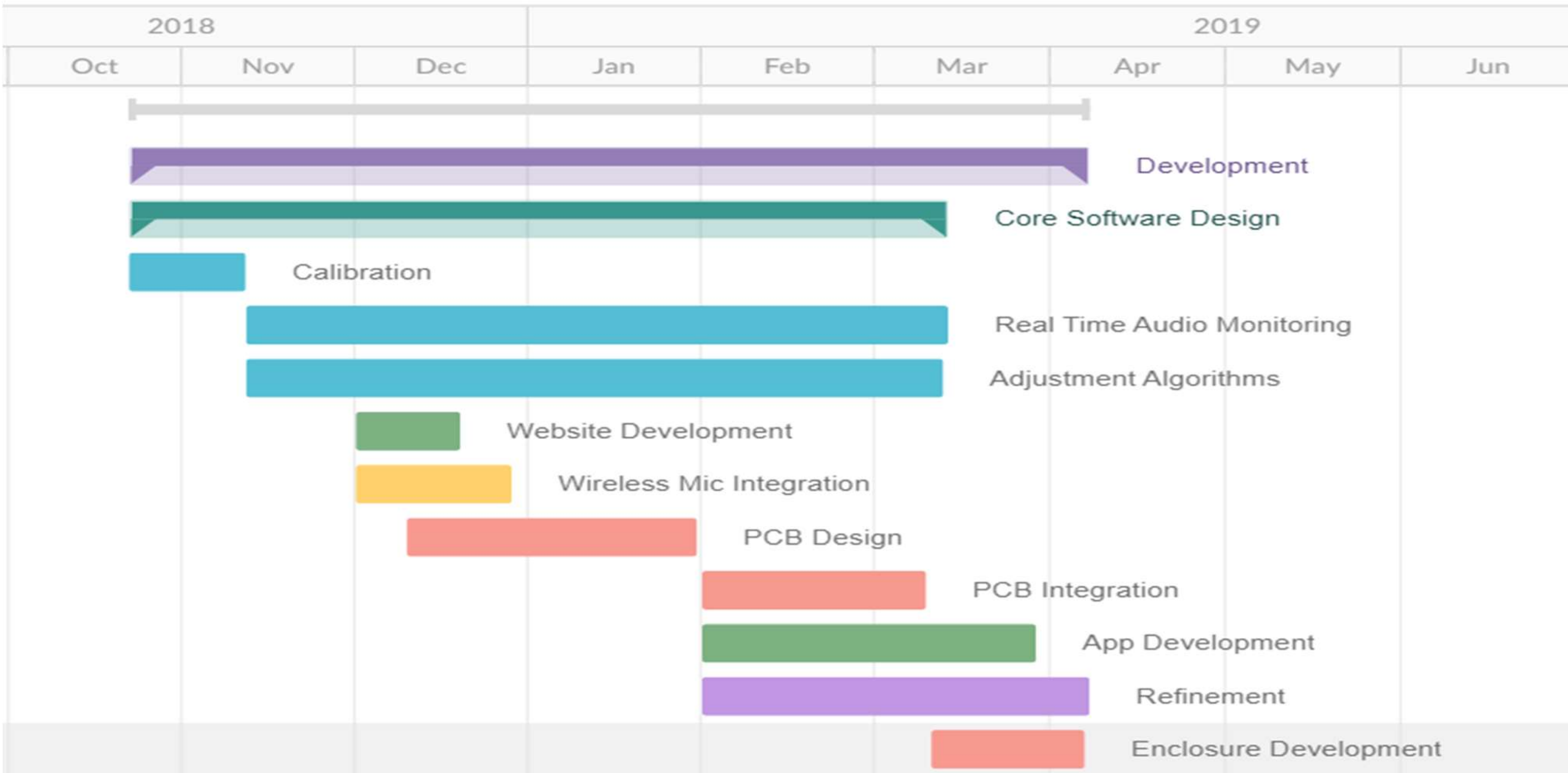
Project Breakdown and Responsibilities

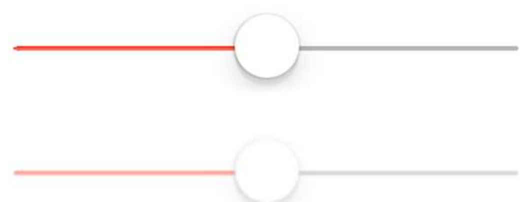
Task name	Start date	End date	Assigned
TurnUp SDP	*10/22/2018*	*04/07/2019*	
Development	**10/22/2018**	**04/07/2019**	
Core Software Design	10/22/2018	03/13/2019	
Calibration	10/22/2018	11/11/2018	R R
Real Time Audio Monitoring	11/12/2018	03/13/2019	N R
Adjustment Algorithms	11/12/2018	03/13/2019	N H
Website Development	12/01/2018	12/19/2018	N Nick Kafasis
Wireless Mic Integration	12/01/2018	12/29/2018	R Rahaun Perkins
PCB Design	12/10/2018	01/31/2019	H Harold Healy
PCB Integration	02/01/2019	03/10/2019	H Harold Healy
App Development	02/01/2019	03/29/2019	R rtwalsh
Refinement	02/01/2019	04/07/2019	R Rahaun Perkins
Enclosure Development	03/11/2019	04/07/2019	H Harold Healy

Gantt Chart


2018
2019
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Development
Core Software Design
Calibration
Real Time Audio Monitoring
Adjustment Algorithms
Website Development
Wireless Mic Integration
PCB Design
PCB Integration
App Development
Refinement
Enclosure Development

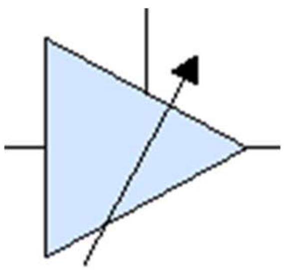
CDR Deliverables

- Basic IOS App that will allow user to choose sensitivity and threshold based with sliders (Ryan)
- System will have the full range of sensitivity(1-10) based on weights of weighted average and size of calculation window (Ryan/Nick)
- System will have full range of thresholds (Expected range of (1.1 - 2) with actual values TBD) (Ryan/Rahaun)



CDR Deliverables

- Microphone will communicate wirelessly with Pi (Rahaun)
- Analog Amplification with Digitally Programmable Gain (Harry)
  - (Instead of Digital Scaling of Samples)



Design Validation

- Graphically show that system increases gain after X seconds of Mic intensity above threshold R
- Consumer satisfaction survey

Challenges Moving Forward

- Integrating the wireless microphone
  - Making sure data is transferred fast enough
- Determining reasonable user preferences through research and polling
- Delivering a clear and concise user interface

Demo

Thank you

Questions?