Calibrating the Microphone of an Android Device

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***Abstract*—To record the frequency response of an inexpensive android device using its internal microphone accurately, calibration must be done to ensure correctness. In the Original Hum Application [1], the frequency response of the recording obtained using the internal android microphone was getting cut-off at the lower frequency ranges (¡30 Hz) because of the limitations involved with the inexpensive recording hardware of the android device. To overcome this limitation, this paper proposes a method to calibrate of the internal microphone of an android device using an external industry grade microphone. The external industry grade microphone used for this purpose is a Mic W i436.**

***Index Terms*—Microphone Calibration, Frequency Gain.**

I. Introduction

In 2008, the residents in the Ranchlands community of Calgary, Canada approached the team at the University of Calgary for assistance in locating the source of a low frequency noise nuisance which became known as the Ranchlands Hum. The Hum is similar to what one would hear when pressing one of the low key notes that is three octaves below Middle C on a piano at approximately 46 Hz. Preliminary analysis of audio recordings were made by Patching Associates Acoustical Engineering Ltd. across a period of 2009 to 2012 in response to community requests for assistance in identifying this noise nuisance. Patching Associates was lending some very hig-end, expensive industrial equipment to residents of Calgary to allow them to record the hum. However, distributing this limited number of expensive equipment to a large number of homes in Calgary was not feasible. Developing a cell phone application to record the data seemed like a viable option as everybody has access to a smart-phone. However, due to the limitations with the inexpensive recording hardware of the android device, the lowest frequency sound recorded with a cell phone application is questionable. This paper proposes a method to calibrate the internal microphone of an inexpensive android device using an industry grade microphone. A constant white noise producing source is recorded using the external microphone plugged into the android devices' microphone jack and second recording using the internal microphone. A calibration file is generated for frequency bands with constant width as the ratio of the frequency response obtained from the external microphone and the internal microphone. This calibration file is used to correct the frequency response generated by the internal microphone at low frequencies.

II. System Description

The calibration of the internal microphone of an android device is described in two stages. The first stage describes the recording captured of a constant white noise generated using Audacity [2] using the external and the internal microphone of the android device. The recordings obtained are converted into their equivalent frequency domain values by computing its discrete Fourier Transform (DFT) using the fast Fourier transform (FFT) algorithm. Stage 2 comprises of calculating the ratio of the frequency response obtained from the two recordings to generate a calibration file. The frequency gain is calculated over 25 Hz frequency band starting from 0 Hz to the maximum frequency that can be accurately recorded.

A. Stage I

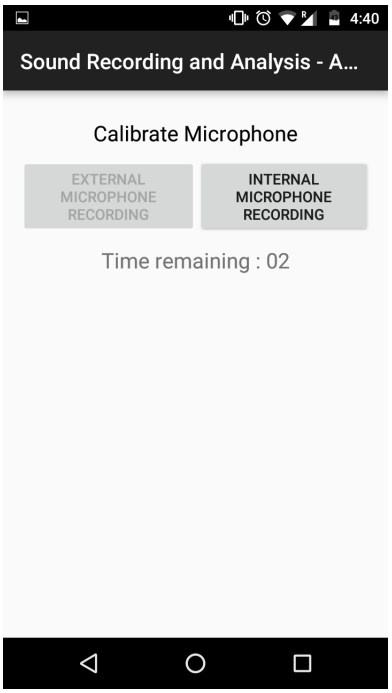

Fig. 1. External Microphone Recording

1) Recordings: A constant white noise generated using Audacity is recorded using the external microphone and the internal microphone of the android device for a duration of 5 seconds. The recordings are sampled at 8000 Hz (8000

samples per second) and 16 bit Pulse-code modulation encoded values (the recorded values range from -32768 to +32767). Since the recordings are sampled at 8000, the highest frequency component that can be recorded is 4000 Hz according to the Nyquist Theorem [3]. The Audio recordings are made using the Android's AudioRecord class. An option to playback the recorded sound has also been made available using the AudioTrack class in android.

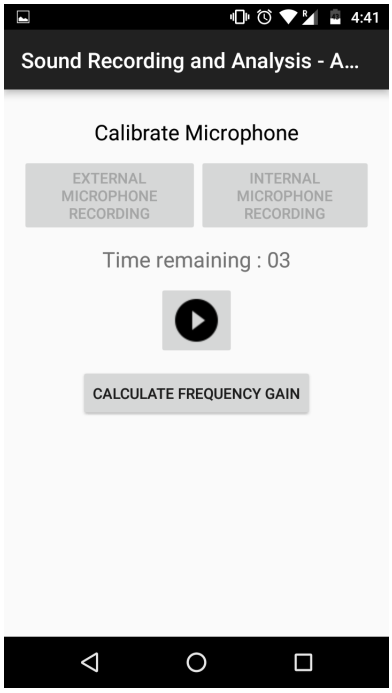

Fig. 2. Internal Microphone Recording

2) Analyzing Recordings: The recorded data (external and internal microphone) is normalized to keep the maximum and the minimum values between -1 to +1. A smoothing effect is then applied on the data to smooth the edges. This application of the smoothing effect is also known as windowing. The data is then converted from time domain into their frequency domain values using the discrete Fourier transform using the fast Fourier transform algorithm. A moving average filter of 32 samples is taken to smooth the spectrum. The averaged smoothed spectrum values are stored in a buffer (called amplitudeBuffer-External/Internal for the recordings made using the external and the internal microphone respectively) and the corresponding values are stored in a buffer (called frequencyValues-External/Internal for the recordings made using the external and internal microphone respectively).

B. Stage II

1) Generating Calibration File: A calibration file is generated by calculating the frequency gain as the ratio of the frequency response from the two recordings. The frequency gain is calculated for a 25 Hz interval from 0 to 4000 Hz. The spectral values associated with each frequency band are averaged over all frequency bands from 0 Hz to 4000 Hz resulting in 160 calibration values.

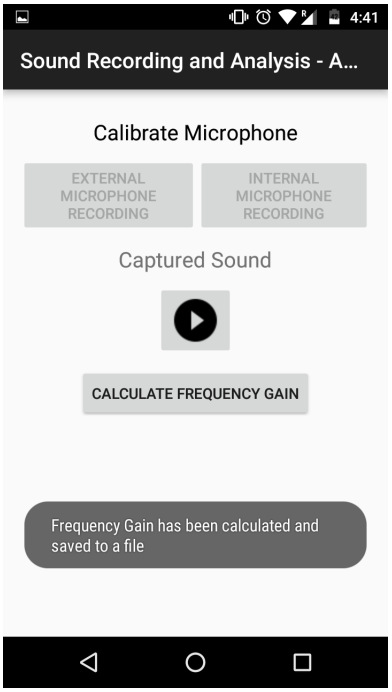

Fig. 3. Calculating Frequency Gain

2) Saving Calibration File: The calibration values are stored in a file in the external SD card if it is present otherwise it is stored in the internal phone storage. The values stored in the calibration file are later used to correct the frequency response of the recorded data obtained using the internal microphone of the android device.

III. Results

A. Using Calibrated Values

The frequency gain values obtained from the calibrated file were used to recalculate the frequency response of the signal recorded using the internal microphone of the android device. It was observed that the frequency response at lower frequencies was not getting cut-off when compared to the recordings made without the use of calibration.

IV. Conclusion

The following observations have been made:

- The calibrated values significantly improved the frequency response at lower frequency values.
- The quality of the industry grade microphone decides the quality of the calibrated values. Better external microphones result in better calibrated values.

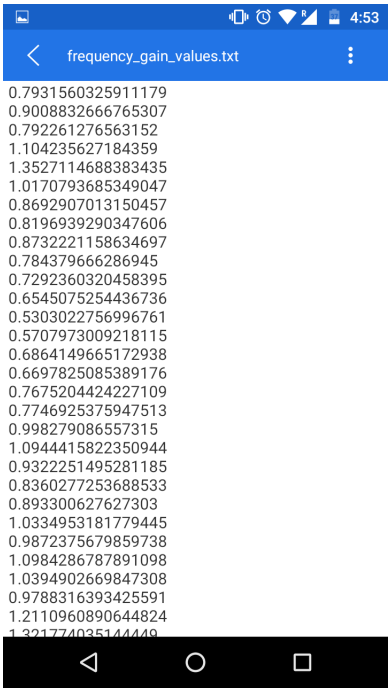

Fig. 4. Calibration File

REFERENCES

[1] Characterization of the Ranchlands Hum, A Calgary Community Noise Nuisance, Smith, Marasco, Epstein, Gupta, Nayak, Patching, Scott
[2] Audacity, An open source tool
[3] https://en.wikipedia.org/wiki/Nyquist