Calibrating the Microphone of an Android Device

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, 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, calibration is done using a calibrated standard industry grade external microphone. The calibration of the microphone of an android device is described in two stages.

Stage I comprises of recording a white noise using an external industry grade microphone and the internal microphone of the inexpensive Android device. The external industry grade microphone used for this purpose is a Mic W i436. The white noise is first recorded by plugging in the external mic into the android device's external jack and recording the sound produced by a constant white noise producing source. The white noise can be produced using an Open Source tool such as Audacity. The recordings obtained in the time domain are converted into their respective frequency domain values using the Fast Fourier Transform. To do so, the recorded data is normalized to keep the maximum and minimum values between -1 and +1. A smoothing effect is then applied on the data to smoothen its edges. This application of the smoothing effect is also known as windowing. After the application of the FFT an array of FFT magnitude values are returned.
This process is repeated after removing the external mic and taking a recording using the android device's internal microphone with the same white noise producing source. A moving average filter of 32 samples is taken to smoothen the spectrum. The averaged smoothed spectrum values are stored in a buffer (called tempBuffer-External/Internal for the recordings made using the external and the internal microphone respectively) and the corresponding frequency values are stored in a buffer (called xVals-External/Internal for the recordings made using the external and the internal microphone respectively).

Stage II comprises of calculating the frequency gain from the two recordings to generate a calibration file. The audio recordings are sampled at 8000 Hz, thereby the highest frequency component that can be recorded is 4000 Hz according to the Nyquist Theorem. The frequency gain is calculated for every 25 Hz interval resulting in the calibrated values being calculated for a bin size of 25 Hz from 0 to 4000 Hz. The calibrated values are obtained as the ratio of the recordings made using the external microphone and the internal microphone. I.e. the ratio of tempBufferExternal and tempBufferInternal over 25 Hz frequency band. After the calibration results have been calculated, the results are saved into a file to be used for calibrating the internal microphone recording in the future.

System Description:
The recordings are sampled at 8000 Hz (8000 samples per second) and a Pulse Code Modulation encoding of 16 bits (values are reported from -32768 to +32767). A recording of 5 second in duration is made for the external microphone and the internal microphone resulting in a buffer size of 40000 units. (sampling_rate * recording_duration). The buffer size is converted to its nearest power of 2 for it to be suitable to be accepted by the Fast Fourier Transform Algorithm to convert the recorded values from the Time domain into the Frequency domain.

Figure 1

A constant white noise producing source Is captured using the external industry Grade microphone.

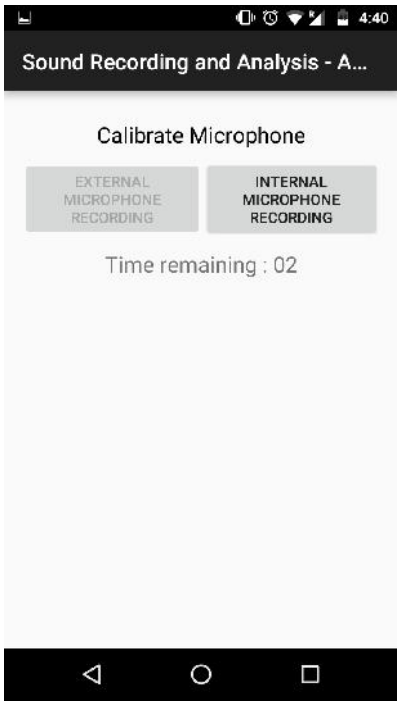

Figure 2

Recording duration of 5 seconds.

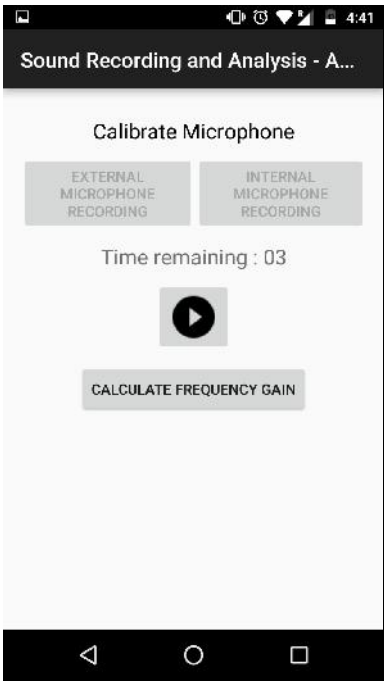

Figure 3

A constant white noise producing Source is captured using the internal Android microphone. Notice the

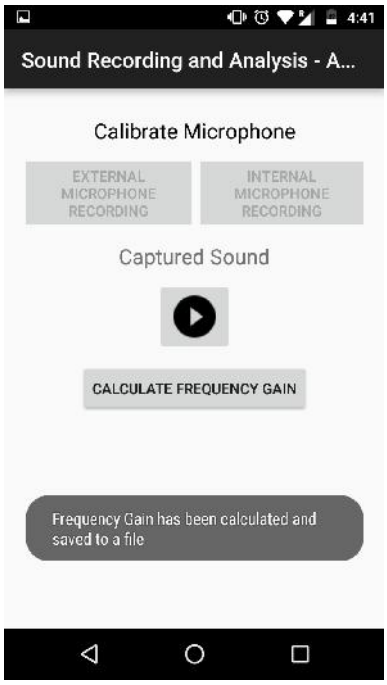

Figure 4

The option to calculate the Frequency is given to generate the calibration file using the procedure mentioned above.

Playback option available after
Every recording.

The calibrated file looks like this: It is stored in the Internal Phone Storage / Memory Card under the Hum_Application directory.

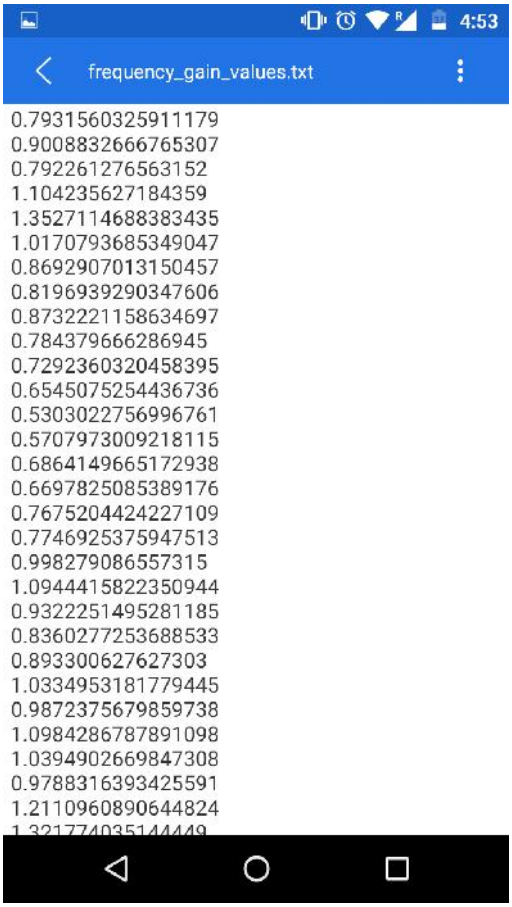

Figure 5