SMARTPHONE AS NOISE LEVEL METER?

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The development of telecommunication hardware and software has led to the availability of instruments that can be used for very different purposes, beyond the basic use as telephonic devices. Through a smartphone, typically furnished with a microphone and a hardware capable of elaborating an adequate signal analysis, it is possible to carry out noise measurements under some accuracy and precision limitations. Moreover there are many free and paid applications that can measure noise levels and turn a mobile phone into a sound level meter. In this work, we will discuss the results of two tests. The first one is a comparison between 5 different smartphones (Android and iOS) and a Class 1 sound level meter, carried out in an anechoic room, relative to the response to white noise at different sound pressure levels. The second is a long term environmental noise measurement (more than 3 months) carried out with a smartphone at the same time with a Class 1 sound level meter. For these tests the free app “Noise Meter” for the Android phones and the paid app “Noise Immission Analyzer” for the Apple ones have been used. The laboratory test showed very good results in certain level ranges, different for each phone, but common for all in the range 45-80 dB. The long term measurement gave also excellent outcomes, with a standard deviation between levels measured, in term of Lden and Lnight parameters, less than 1 dB.

1. Introduction

In this work we've investigated the possibility of using a smartphone as a noise level meter.

Indeed, smartphones have all the components to make noise measurements: a microphone for signal detection, a hardware for digital analysis, a display for visualization of data.

But is it possible to carry out noise measurements with these devices under some accuracy and precision limitations?

To answer to this question two tests have been conducted.

The first one has been done in an anechoic room, comparing the response of 5 different smartphones and a Class 1 sound level meter.

The second test is a long term outdoor noise measurement (more than 3 months) carried out simultaneously with a smartphone and a Class 1 sound level meter.

2. Smartphones and apps

The smartphones used for the tests are: Samsung @chat GT-B5330 (Android v.4.0.4), Samsung Advance GT-I9070P (Android v.2.3.6), HTC Desire 601 (Android v.4.4.2), iPhone 4S (iOS v.8.0.2), iPhone 5S (iOS v.8.1.3).

The free app “Noise Meter” and the paid app “Noise Immission Analyzer” for the Apple ones have been employed.

Figure 1. Noise Meter (left) and Noise Immission Analyzer (right) logo.

Figure 2. A screen of the two apps.

2.1 Noise Meter for Android

The application is free and downloadable from Google Play; the developer is JINASYS.

The characteristics, for the version 2.8.1, are:

- sampling frequency adjustable: 8000, 11025, 22050, 44100, 48000 Hz;
- 1 dB steps gain, in the range -40 - +40 dB;
- integration period from 1 sec to 10 minutes;
- events detection;
- digital filters: low-high-band pass, A ponderation;
- data capture: peak, minimum, maximum, arithmetic average, energetic average (equivalent level).

It’s possible to save noise data in a text file; for each sample date, time, peak and energetic average are stored. It’s not possible to measure frequency spectrum.

2.2 Noise Immission Analyzer for iOS

The application, developed by WaveScape Technologies GmbH (http://www.wavescape-technologies.com/), is no more available at the moment, for unknown reasons.

When downloaded, it was not free (there were additional paid modules to increase functionality).

The characteristics, for the lower module of the version 2.0.1, are:

- sampling frequency: 44100 Hz;
- calibration with a known signal;
- digital filters: A-B-C-linear ponderation, fast, slow;
- data capture: minimum, maximum, energetic average (equivalent level);
- audio file record up to 20 seconds.

For the module used, it's not possible to save noise data in a text file nor to measure frequency levels.

3. Laboratory measurements

The first laboratory test was conducted comparing the response to white noise, at different values of SPL, by the smartphones and a Class 1 sound level meter.

Figure 3. The 5 smartphones and the Class 1 microphone.

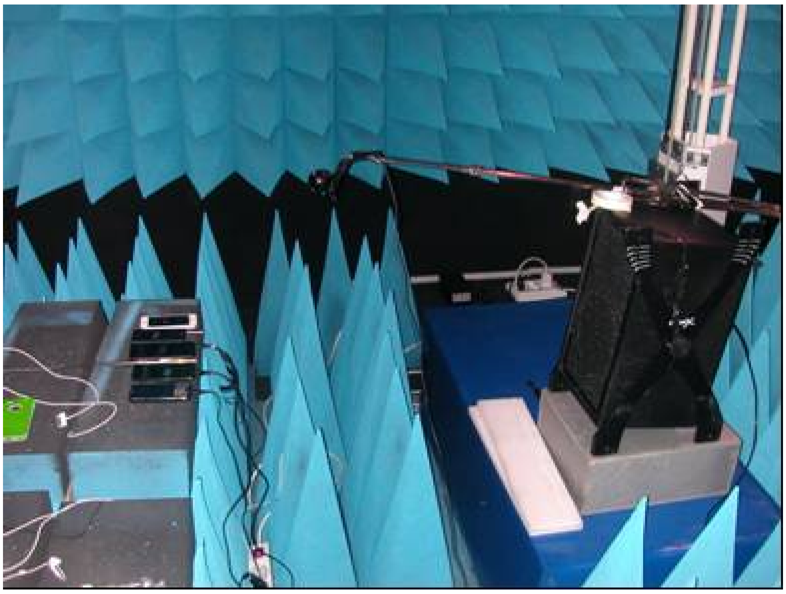

Figure 4. The amplifier generating white noise.

Figure 5 shows the results obtained using the internal microphone of the smartphones. The phones were calibrated at 70 dB(A); the gain of the Android devices was set at 10 dB for the HTC, 9 dB for the Samsung Advance and 6 dB for the Samsung @chat.

In the range 45-80 dB(A) the response is very good and restrained into 2-3 dB for all the devices. The iOS phones response remains under 1 dB difference up to 110 dB(A).

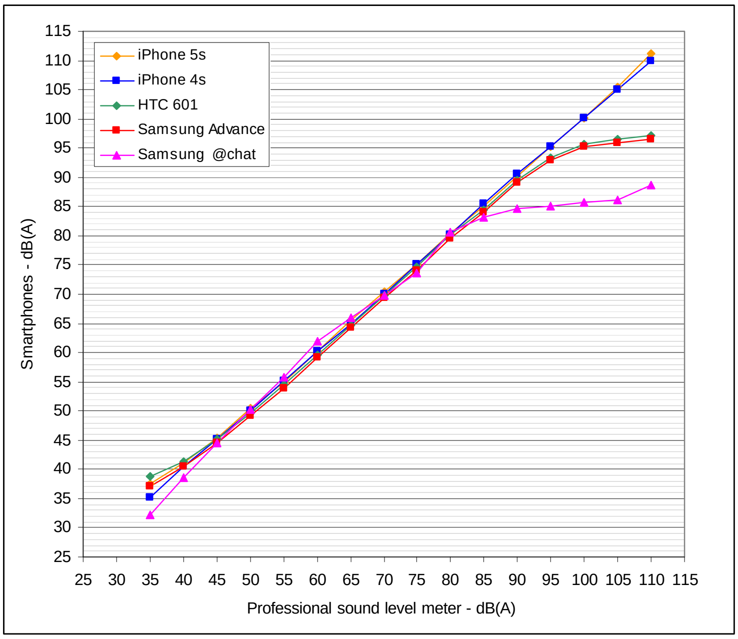

Figure 5. Comparison with the internal microphone of smartphones.

Figure 6 illustrates the results of the test using for each smartphone the original headphone microphone. In this case the response is very good in a smaller range, 60-80 dB(A), for all the devices, and acceptable in the 40-85 range (2-3 dB deviation) for the iOS ones and for the Samsung Advance; the HTC model is worse in low levels while is better in higher.

The gain of the Android phones was set at 47 dB for the HTC (40 directly added by the app and 7 in post-processing analysis), 14 dB for the Samsung Advance and 15 dB for the Samsung @chat.

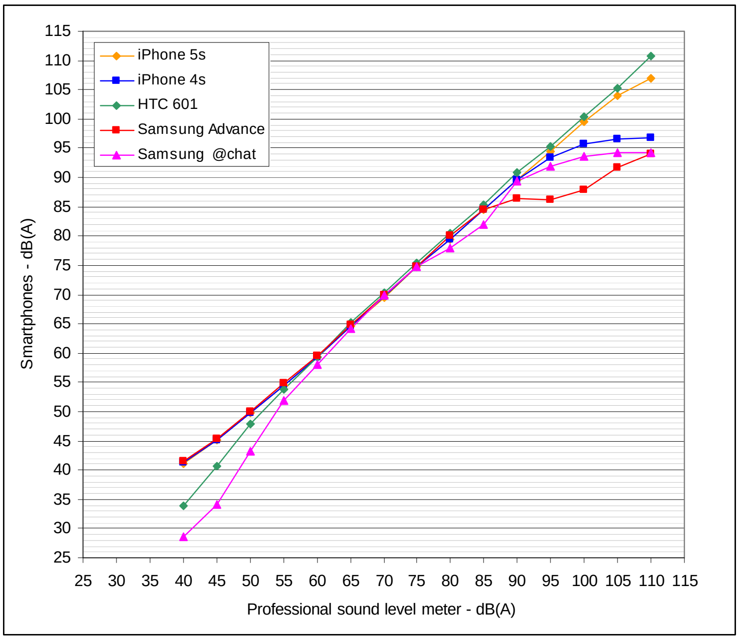

Figure 6. Comparison with the original headphones of the smartphones.

Figure 7 shows the results using a MicW microphone, i436 Omni Mic model (http://www.mic-w.com/), plugged into the smartphones. In this case the response is very good in the range 40-110 dB(A) for the iOS and in the range 55-110 dB(A) for the HTC. The gain of the HTC was set at 45,5 dB (40 directly added by the app and 5,5 in post-processing analysis). The test was not made for the Samsung phones.

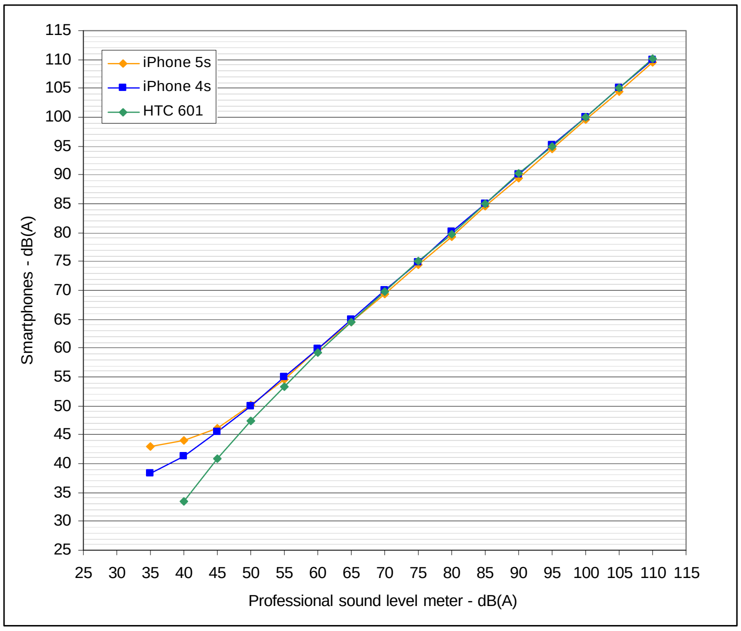

Figure 7. Comparison using the MicW microphone plugged into the smartphones.

In addition to these tests, an evaluation of the frequency response for the Samsung Advance smartphone has been investigated. The experiment was done measuring pure tones, in the range 50-10.000 Hz and with variable intensity, in comparison with a Class 1 sound level meter. Since Noise Meter does not allow the measurement in frequency bands, the analysis was made comparing the global equivalent noise levels. The two detectors were collocated inside a box that can simulate the characteristic of an anechoic room.

The next figure shows the results obtained: the behaviour of the smartphone in the frequency range 160 - 5000 Hz is excellent up to 80 dB(A).

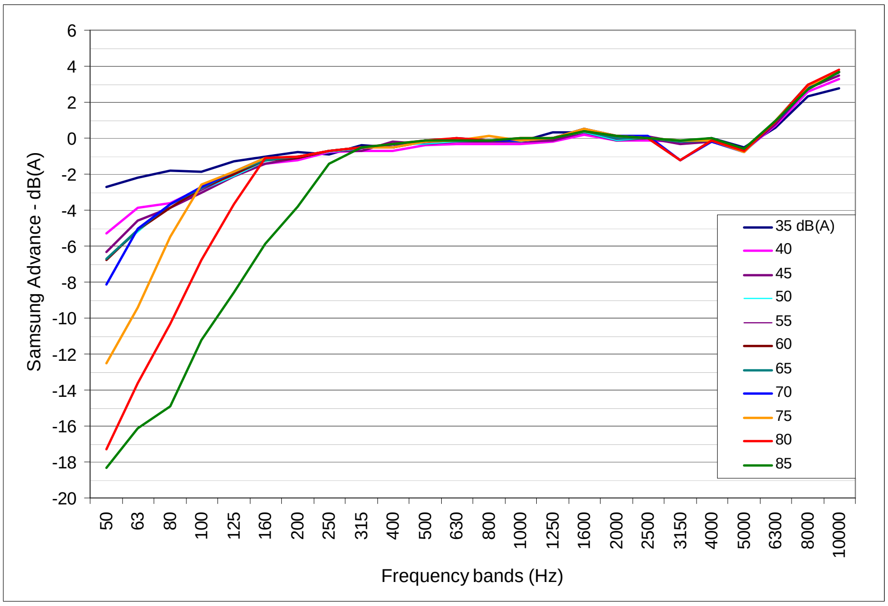

Figure 8. Amplitude and frequency response for the Samsung Advance in comparison with a Class 1 noise meter level.

4. Outdoor measurements

Following the good results obtained by the laboratory tests, a road traffic noise measurement campaign was performed for more than 100 days using the Samsung Advance smartphone (with headphone microphone) simultaneously to a Class 1 sound level meter.

The instruments were both positioned on the terrace of a building of the Municipality of Turin.

The weather conditions were variable, including rain and wind; the smartphone microphone was protected by headphones windproof and the phone was collocated in a waterproof case.

In Figure 10 the comparison of the A-weighted level time history measured by the two systems for a short period (6 min.), with samples every second, is represented.

The results in term of Lden (day 6-20, evening 20-22, night 22-06), Lnig (06-22) and Lday (06-22, Italian law period) are shown in Figure 11.

Finally, in Table 1 the average, minimum, maximum and the standard deviation of the differences, calculated on the 5-minute L_{Aeq} data series for all the monitoring period (104 days), are reported.

All the data obtained reveal a very good accordance between the two instruments, with standard deviations of the differences always smaller than 1 dB.

Figure 9. Environmental noise measures on the terrace of a building.

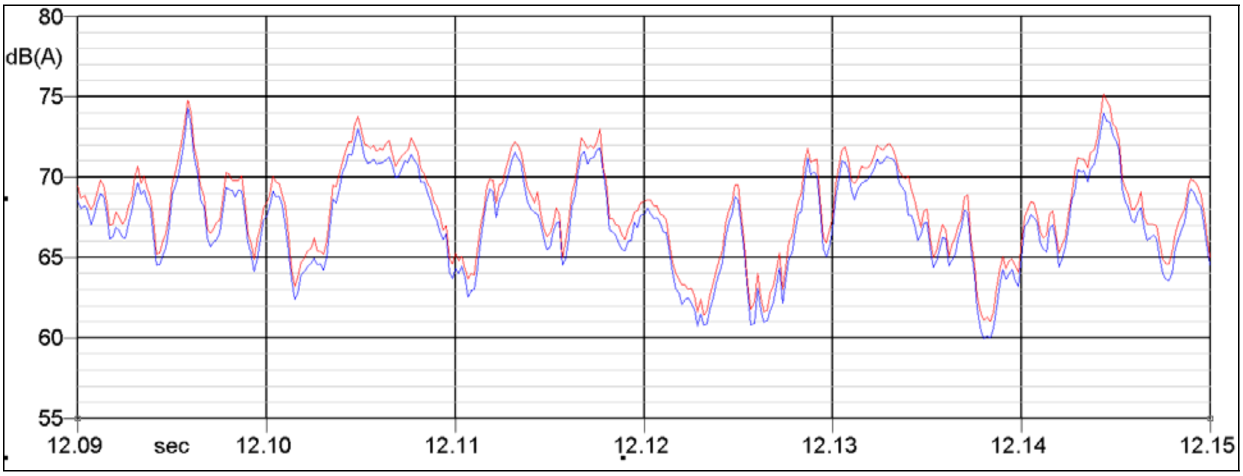

Figure 10. Comparison of the noise level measured by the smartphone (blue line) and by the Class 1 sound level meter (red line).

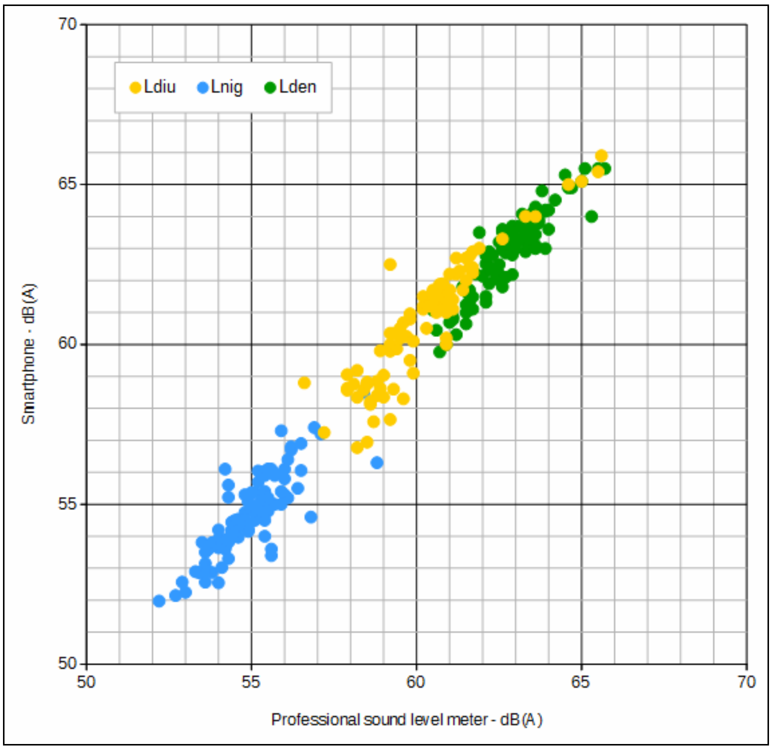

Figure 11. Comparison between smartphones and Class 1 sound level meter, parameter Lday, Lnig, Lden.

Table 1. Statistic analysis of the difference between the two measurements (5-minute L_{Aeq} for 104 days).

	$L_{Aeq,Class\ 1} - L_{Aeq\ smartphone}$ dB(A)		
	Day	Nig	Den
Minimum	-3,3	-1,9	-1,6
Average	-0,5	0,3	-0,1
Maximum	1,6	2,5	1,3
Standard deviation	0,8	0,7	0,5

5. Conclusion

The results obtained through laboratory and on field measurements show that all the smartphones tested can measure noise levels in the range 40-85 dB(A) with a good accuracy and some of them can correctly be employed up to 110 dB(A).

Starting from these results, we are going to develop a free and open-source app, in Android environment, to be used both with smartphones and with a low cost noise level meter we've been building with an electronic programmable board. We are working to this project with a team composed by Arpa, Politecnico di Torino (DAUIN - Department of Control and Computer Engineering) and Istituto Superiore Mario Boella (www.ismb.it).