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So How Good are These Smartphone Sound Measurement Apps?

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Introduction

As of June 2013, smartphone penetration in the U.S. market has reached more than 60% of all mobile subscribers with more than 140 million devices. Apple iOS and Google Android platforms account for 93% of those devices [Nielsen, 2013]. Smartphone developers now offer many sound measurement applications (apps) using the devices' built-in microphone (or through an external microphone for more sophisticated applications). The ubiquity of smartphones and the adoption of smartphone sound measurement apps can have a tremendous and far-reaching impact in this area as every smartphone can be potentially turned into dosimeter or sound level meter [Maisonneuve et al., 2010]. However, in order for smartphone apps to gain acceptance in the occupational environment, the apps must meet certain minimal criteria for functionality, accuracy, and relevancy to the users in general and the worker in particular.

This study aims to assess the functionality and accuracy of smartphone sound measurement apps as an initial step in a broader effort to determine whether these apps can be relied on to conduct participatory noise monitoring studies in the workplace [Kardous and Shaw, 2014].

Experimental Setup

We selected and acquired a representative sample of the popular smartphones and tablets on the market as of June 2013. Smartphone apps were selected based on occupational relevancy criteria: (1) ability to report unweighted (C/Z/flat) or A-weighted sound levels, (2) 3-dB or 5-dB exchange rate, (3) slow and fast response, and (4) equivalent level average (Leq) or time-weighted average (TWA). Also, considerations were given to apps that allow calibration adjustment of the built-in microphone through manual input or digital upload files, as well as those with reporting and sharing features. Ten iOS apps out of more than 130 apps were examined and downloaded from the iTunes store as shown in Table 1.

Four Android based apps, (out of a total of 62 that were examined and downloaded) partially met our criteria and were selected for additional testing. As a result, a comprehensive experimental design and analysis similar to the iOS devices and apps study above was not possible. In addition to the low number of apps available with similar functionality, there

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was a high variance in measurements and a lack of conformity of features of the same apps between different devices. Only a few apps were available on the Windows platform but none met our selection criteria.

The measurements were conducted in a diffuse sound field at a reverberant noise chamber at the NIOSH acoustics testing laboratory. For our experimental setup, we generated pink noise with a 20Hz – 20kHz frequency range, at levels from 65 dB to 95 dB in 5-dB increments (7 different noise levels. Reference sound level measurements were obtained using a ½-inch Larson-Davis (DePew, NY) model 2559 random incidence microphone. Additionally, a Larson-Davis Model 831 type 1 sound level meter was used to verify sound pressure levels. Smartphones were set up on a stand in the middle of the chamber at a height of 4 feet and approximately 6 inches from the reference microphone as shown in Figure 1.

Results

In order to see which apps provided measurements closest to the actual reference unweighted and A-weighted sound levels, we compared the means of the differences using multiple pairwise Tukey comparisons, as shown below in Table 2.

Discussion

The results reported in Table 2 show that the SoundMeter app had the best agreement, in A-weighted sound levels, with a mean difference of -0.52 dBA from the reference values. The SPLnFFT app had the best agreement, in un-weighted sound pressure levels, with a mean difference of 0.07 dB from the actual reference values. For A-weighted sound level measurements, Noise Hunter, NoiSee, and SoundMeter had mean differences within ± 2dBA of the reference measurements. For un-weighted sound level measurements, NoiSee, SoundMeter, and SPLnFFT had mean differences within the ± 2 dB of the reference measurement. The agreement with the reference sound level measurements shows that these apps may be considered adequate (over our testing range) for certain occupational noise assessments.

Overall, the Android-based apps lacked the features and functionalities found in iOS apps. This is likely due to the development ecosystem of the Android marketplace and users' expectations for free or low priced apps and the fact that Android devices are built by several different manufacturers.

Challenges remain with using smartphones to collect and document noise exposure data. Some of the main issues encountered in recent studies relate to privacy and collection of personal data, sustained motivation to participate in such studies, bad or corrupted data, and mechanisms for storing and accessing such data. Most of these issues are being carefully studied and addressed [Drosatos et al., 2012; Huang et al. 2010].

Biography

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Figure 1.

The SoundMeter app on the iPhone 5 (left) and iPhone 4S (right) compared to ½” Larson-Davis 2559 random incidence type 1 microphone (center).

Table 1

List of iOS smartphone sound measurement apps.

App	Developer	Features
Adv Decibel Meter Decibel Meter Pro	Amanda Gates Performance Audio	A/C weighting, Int/Ext mic, Calibration A/C/Z weighting, Calibration
iSPL Pro	Colours Lab	A/C/SPL weighting, Calibration
Noise Hunter	Inter.net2day	A/C/SPL weighting, Int/Ext mic, TWA, Calibration
NoiSee	IMS Merilni Sistemi	A/C/Z weighting, ISO/OSHA, Dose, Calibration
Sound Level Meter	Mint Muse	A/C/SPL weighting, Calibration
SoundMeter	Faber Acoustical	A/C/SPL weighting, Leq, Int/Ext mic, Calibration
(Real) SPL Meter	BahnTech	A/C/SPL weighting, Calibration
SPL Pro	Andrew Smith	A/C weighting, Leq, Int/Ext mic, Calibration
SPLnFFT	Fabien Lefebvre	A/C/SPL weighting, Leq, Int/Ext mic, Calibration

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Table 2

Means of differences in unweighted and A-weighted sound levels using Turkey multiple pairwise comparisons.

App	N	Mean (dB)	S. E. (dB)	Mean (dBA)	S. E. (dBA)
Adv Decibel Meter	168	3.7875	0.25718	−5.0464	0.27668
Decibel Meter Pro	168	−8.6500	0.32718	−13.1708	0.27644
iSPL Pro	168	−7.4274	0.27222	−2.5792	0.25884
Noise Hunter	168	−12.2161	0.33186	−1.9280	0.27227
NoiSee	168	1.9702	0.29079	−1.1280	0.25253
Sound Level Meter	168	6.7649	0.29457	3.6083	0.27926
SoundMeter	168	1.7595	0.23338	−0.5185	0.12852
(Real) SPL Meter	168	−5.5857	0.30416	−13.1327	0.27929
SPL Pro	168	2.7851	0.23576	2.4863	0.11935
SPLnFFT	168	0.0696	0.35569	−2.2744	0.25715