A discussion of the use of app-based noise measurement tools

By James Tingay

There has been a growing awareness in the acoustics community as to the availability and application of apps that can provide noise measurement functions.

Some of these apps have been designed to meet, when used with a suitable external microphone, compliance with the relevant instrumentation standards.

The vast majority of apps are available as free downloads from the Google Play Store or the Apple App Store giving users a vast selection to choose from, and when combined with the range of devices available, there is potential for significant variations in the accuracy, function and performance of the measurement chain.

The purpose of this discussion is not to identify individual apps or to recommend one platform (iOS or Android) over another but to give an overview of the current usage of apps and to highlight whether users of these apps are considering the potential areas of measurement uncertainty that may arise when doing so.

How widely used are apps for noise measurements?

A significant proportion of the noise measurement equipment sold both in the UK and overseas is used for compliance with occupational noise regulations such as the Control of Noise at Work Regulations 2005 and it is within this area that we see the most widespread use of apps.

To estimate the usage, a brief survey was carried out using current users of Cirrus noise measurement equipment to see if they are using apps and whether they have considered any of the aspects raised above.

The users have been identified as Noise at Work where the primary use of noise measurement equipment is for the measurement of occupational noise and environmental where the primary use is for environmental noise measurements. There is some crossover between these two groups so to remove duplication, the primary usage was used.

Are you or have you used a noise measurement app for work purposes?	Yes	No
Noise at Work	40%	60%
Environmental	17%	73%

Within the Noise at Work arena, users are often implementing apps as a way of making an initial assessment of noise levels or to give other stakeholders a simple way to raise concerns about changes in noise levels.

Environmental users are seeking levels and recordings of sounds that are of concern to them, or populating complaint management apps issued by councils or others.

Internal or external microphone?

There are plenty of online discussions, including within the IOA LinkedIn group, as to the use of apps using external microphones and there are a number of manufacturers who have developed microphone systems that can be used, primarily with iOS-based devices, to provide an external input to the measurement system.

The question of how accurate, for want of a better description, a noise measurement app could be using an internal microphone has been discussed at length previously in a number of papers[1].

One showed that using the same app across a number of different devices and in a controlled environment gave P18

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differences of between -28dB(A) and +10dB(A) when compared with a reference sound level meter.

The most significant differences were shown when the noise contained a high proportion of low frequency content or where the measured noise contained a significant impulsive component (not uncommon within a manufacturing environment).

The chart below shows the differences, relative to measurements made with a calibrated class one sound level meter, for different combinations of device, app and noise content.

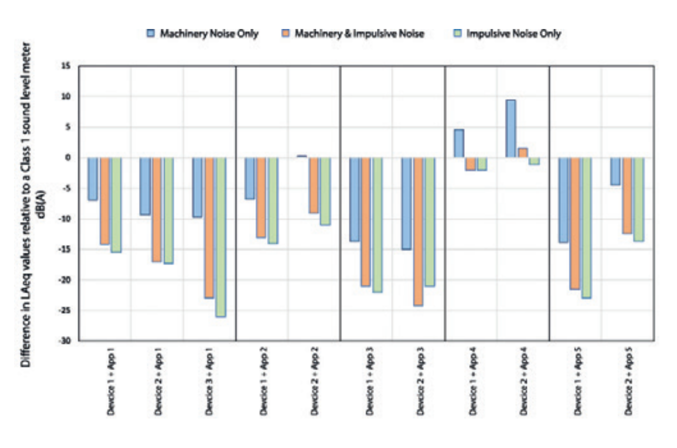

Figure 1 Comparison of same app running on different similar form devices, relative to IEC61672 Class 1 SLM

It is clear from this data that the more impulsive content there is within the noise source, the larger the difference from the reference measurement can be.

A second example below shows the relative difference in readings between a single device running three different apps, relative to data recorded by a calibrated class one sound level meter.

The measurements were made using a microphone on the supplied headphone cable, the internal microphone (or microphones) and an external microphone/preamplifier.

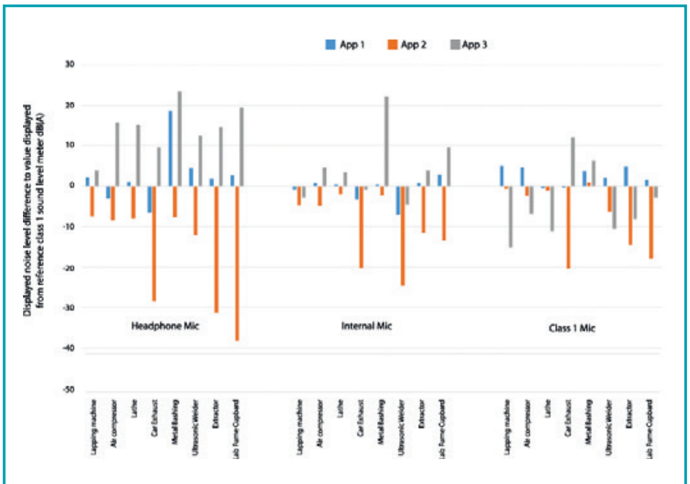

Figure 2 Difference in readings for a single iPad device, measuring different workplace noise with three different apps

Again, as with the test of the same app on different devices, the relative difference between the measurements made with a calibrated class 1 sound level meter has a wide spread with readings between -38dB(A) and +24dB(A) being recorded.

A recent test of an app using a new iPad showed a discrepancy of up to 10dB between measurements. This appeared to be caused by the use of multiple microphones on a device, especially where one or more of the microphones is being used automatically for noise cancellation.

This effect was more pronounced at low levels below 40dB(A) where this could significantly impact upon environmental noise measurements and calculations where the statistical distribution of the noise is an important metric.

It is possible to disable the automatic noise cancellation but it does seem unlikely that the more casual user would delve into the accessibility settings to do this, especially if the device were to be used for other voice enabled applications such as Skype or Facetime.

Calibration of the measurement chain

In this instance, the question of calibration refers to verification that the device is displaying an accurate value at a single frequency and level, rather than to periodic verification to IEC 61672-3 for example.

Users who had used an external microphone were generally aware of the need to calibrate their device before taking measurements. However, the majority who were relying on the internal microphone had not considered that calibration would be required.

A comment from one user was that they had assumed that the developer of the app would have ensured that the level was correct, questioning why they would need to take any calibration into account. They were using the same app on two different devices and were seeing significant differences between the two configurations.

Another comment was that they had tried to use a standard acoustic calibrator as a reference but the calibrator kept switching off as it did not detect that a microphone had been inserted into the cavity.

Positioning of the device

The orientation or positioning of the device has been shown in previous studies to be a significant factor that can have a significant affect upon the frequency response of the measurements.

Most smart phones use a microphone that is positioned at the lower edge of the device in the space where the designers would expect the user's mouth to be. Some devices now use multiple microphone capsules spread over the body of the device to allow for noise cancellation, enhancing the quality of speech.

The location of the microphone on tablets is more variable as these are not intended to be used for calls.

Most modern devices will auto-rotate the display as the user moves the phone with the result that the microphone could possibly be in one of four different positions. A quick sample of users of smart phones and tablets showed that unless that were made aware of the position of the microphone they would hold the device with the microphone typically facing their body, sometimes with the body of the device touching their clothing, further affecting the frequency response of the device.

The technical requirements of the current sound level meter standards have dictated that the microphone capsule is located at the top of the instrument.

One interesting point that appeared from this simple survey was that those who had used (or were frequently using) a handheld sound level meter were often putting the microphone close into their body. When questioned as to why this was, the feedback was that they were unaware of or had not considered where the microphone on the device was located.

Standards, consistency and repeatability

One question that is often discussed is whether this type of app could, or should, be used where there is a requirement to meet a standard or regulation.

Most sound level meters currently being manufactured comply with IEC 61672-1, often with the subsequent Type Approval to IEC 61672-2 and then periodic verification to IEC 61672-3. The standards, regulations and guidelines to which most of us are working will specify that an instrument should meet class one or class two of this standard.

The user instructions for the NIOSH sound level meter app contain a disclaimer that "...we want to emphasize that smartphones and smartphone sound apps were not designed to meet such rigorous standards and that this app does not meet P20▸

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type 2/class 2 standards and should not be used for compliance purposes". Other apps have similar statements or none at all!

What is being measured?

A further question to be asked is to what the apps are truly measuring and displaying.

An evaluation of 25 sound level meter apps on the Google Play Store showed that only six labelled the metric being displayed correctly. Where this was not the case, the majority were using SPL, often with no indication of the frequency or time weighting being used.

Where some form of averaging was available, only eight of the apps used displayed Leq or TWA as a metric. The others used Average or Mean as a descriptor. Using a quick, visual check using a controlled noise source that stepped by +20dB, some even appeared to be using a simple linear average.

The clear risk here is that the user may not be aware of whether the app is providing the appropriate metric or whether the processing of raw data to provide those metrics is correct.

In the example below, the sound level meter is showing the current LAF, LAFmax and LAFmin values of 55.9dB(A), 90.6dB(A) and 54.5dB(A) respectively.

The app is showing 61, 76 and 39 respectively but with no indication as to the applied time and frequency weighting. This is not a judgement on a specific app but an example of how the information displayed could be misleading.

Conclusion

As stated in the introduction, the aim of this review is not to approve or disapprove of the use of apps for sound level measurements. There are plenty of apps that, when used with the appropriate microphone, can be an effective and accurate way to take measurements.

However, we should be aware that a significant proportion of the users of noise measurement equipment are not noise professionals and could be at risk of using inappropriate equipment to take what could be business critical measurements.

Education and information is key.

Figure 3 Comparison of a randomly selected app vs Class 1 sound level meter

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References

1. Comparative study of the performance of smartphone-based sound level meter apps, with and without the application of a ½" IEC-61094-4 working standard microphone, to IEC-61672 standard metering equipment in the detection of various problematic workplace noise environments David P. ROBINSON; James TINGAY, Internoise 2014