STUDY OF THE COMPLIANCE OF A SOUND INTENSITY MAPPING DEVICE LOCATED IN SPACE BY COMPUTER VISION WITH CONVENTIONAL CERTIFIED METHODS FOR MEASURING SOUND POWER

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1. INTRODUCTION

A new real-time sound intensity mapping device, the *I-Track*, proposes a mean of measuring sound power that is based on sound intensity probe sweeps over planar surfaces coupled to a machine vision algorithm that associates each sound intensity measurement with coordinates in a common spatial reference. The innovation of this method relies, in particular, in the use of Fresnel ellipses and Delaunay triangulation in the process of averaging and interpolating the intensity data over the entire scanned area, which can subsequently be integrated to obtain the sound power. The main advantage of the *I-Track* device over conventional sound intensity measurement system is that the implemented spatial-based procedure allows obtaining contour maps of intensity without performing tedious point-by-point measurements by simply scanning over the area without following prescribed patterns as long as the whole area is entirely covered [1].

The conformity of the sound power data obtained with this method has never been the object of a formal investigation. Thus, it is the goal of this study to quantify the compliance of the results obtained with this technique with those obtained with standard certified methods. A first comparison was made by measuring sound intensity at discrete points, as described in the *ISO 9614-1* [2], using a calibrated source. Another comparison was made by performing sound intensity scanning as prescribed in the *ISO 9614-2* [3]. Finally, the results were also compared to the sound power data provided by the manufacturer of the calibrated source, such data being obtained using a standard microphone measurements method described in the *ISO 3745* [4].

2. METHODS

The measurements were undertaken in a semi-anechoic chamber. A calibrated source, the *Acculab RSS-400, was used as a noise source*. A rectangular virtual volume of 110 cm by 120 cm by 120 cm was defined symmetrically around the source in order to determine the measuring areas. The noise source is around 30 cm of height and approximately 25 cm wide. Since the noise source was placed on the ground, a reflective surface, 5 faces of the virtual volume were used for the intensity measurements. All the measurements (*I-Track* & standard procedures) were performed with the same microphones.

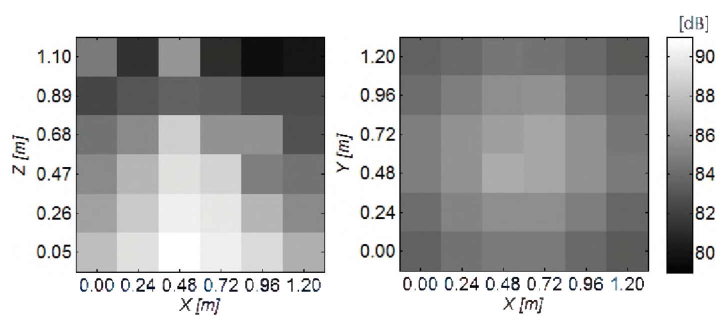
The measurements at discrete points were performed in accordance with the *ISO 9614-1* directives. Because of the radial symmetry of the source, only the top and one of the side faces were considered. For each of these surfaces, a 6 by 6 grid (36 evenly distributed measurement points) was used. For each of the 36 points, the duration of the measurement was approximately 20 seconds, which is considered enough for the data to stabilize over time and is consistent with the standard.

Sound intensity measurements by the scanning procedure were executed in accordance with the *ISO 9614-2*. Measurements using this method were performed for the top surface and all side surfaces. The sweeping speed always remained under 0.5 m/s and the scanning was uniform over the whole surface as prescribed by the standard.

As an alternative to the standard measurements, the *I-Track* device was used to generate sound intensity mapping, also in accordance with the *ISO 9614-2*. As mentioned previously, the *I-Track* device contains a localization apparatus that records the position of the intensity probe through a computer vision algorithm. As it was the case for the standard point-by-point measurement procedure, only the top and one of the side surfaces were considered.

3. RESULTS

Figure 1 presents the overall sound intensities (from 100 to 10k Hz) obtained using the standard point-by-point measurement procedure described above.



(a) Side Surface (b) Top Surface

Figure 1 - Sound intensities obtained for the "measurement at discrete points" method (ISO 9614-1)

A 3D representation of the experimental setup, along with an interpolation of these results is shown in figure 2. The cylindrical object exposed in figure 2 represents the source.

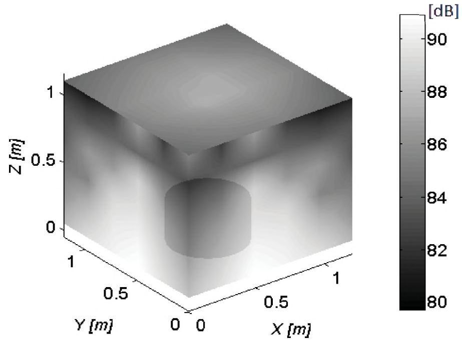


Figure 2 – 3D Representation of the interpolated global sound intensities for the "discrete points" method (ISO 9614-1)

Figure 3 presents the sound power obtained using the three different measurement procedures. Additionally, the source manufacturer's data was also added as a reference. As indicated by the manufacturer, this data was obtained using the hemi-anechoic calibration method described in the *ISO 3745* [4].

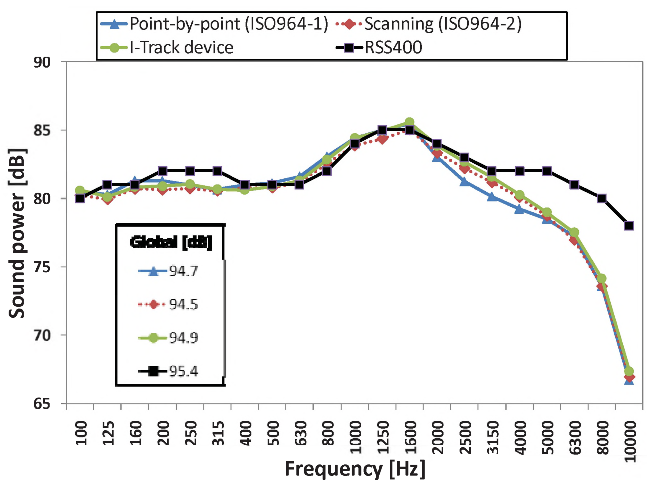
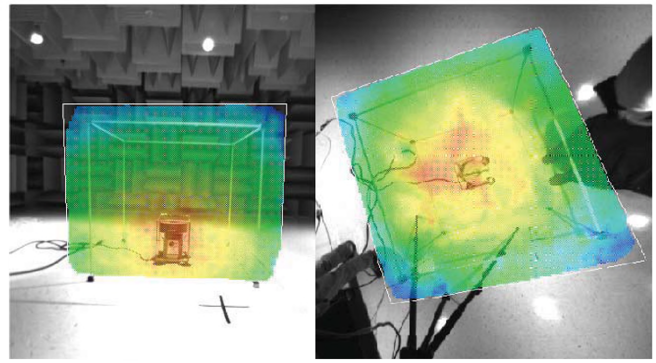


Figure 3 – Comparison of the sound power obtained with the ISO methods and the I-Track device. RSS-400 calibrated source data are given as a reference

Finally, figure 4 shows the overall sound intensity obtained with the *I-Track* sound mapping device. It is observed that the intensity distribution is similar to what was obtained with the measurements at discrete points.



(a) Side Surface (b) Top Surface

Figure 4 – Global sound intensity calculated using the *I-Track* sound mapping device

4. DISCUSSION & CONCLUSION

As it is shown in figure 3, fairly good agreement was obtained between the three methods used in this study. Indeed, the differences in sound power levels for the various third octave bands remain under 1 dB and are under 0.5 dB for the overall sound power. These differences are within the uncertainty range of the devices used. It can thus be concluded that data obtained with the *I-Track* device is in good accordance with the ISO standard. The interpolation technique based of Fresnel ellipses and Delaunay triangulation seem to give more than adequate results over the spectrum of interest.

Notable differences were observed between the measurements data and the reference curve of the source for sound power values over 3.15 kHz. It is still unclear why there is such divergence and this issue is under investigation.

In conclusion, it has been shown that the sound intensity calculated from the *I-Track* sound mapping device complies with other intensity measurement methods, the *ISO 9614-1* and *ISO 9614-2*, over the studied frequency range. The difference is under 1 dB and within the range of uncertainties. Total sound power values as well as intensity contour maps were shown to be well captured by the I-Track device.

REFERENCES

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