COMPARISON BETWEEN SOUND INTENSITY PROBES AND ACOUSTIC CAMERAS

James Wren | March 15, 2010 | transducers | 4 Comments

Sometimes we are asked about the differences between an acoustic camera and a sound intensity probe and which of the two is better for a particular application. There is no straightforward answer as they are quite different pieces of equipment, used for measuring different things. An acoustic camera is a tool used to locate and analyse sound sources, usually both steadystate and dynamic phenomena. The intensity probe is used to find the sound intensity at a particular position, usually a steadystate phenomena.

ACOUSTIC CAMERAS

An acoustic camera consists of some sort of video device, such as a video camera, and a sound pressure measuring devices, such as microphones, sound pressure is usually measured as Pascals (Pa). The microphones are normally arranged in a pre-set shape and position with respect to the camera.

The user points the acoustic camera at the object under test. They then 'see' the video overlaid with the sound pressure levels. Say, for example, an automotive vehicle engine was running on a test bench. If you were to point an acoustic camera at the engine you would see the image of the engine on the display, but also see the sound pressure levels and the frequencies of these levels (similar to that shown in Figure 1 below).

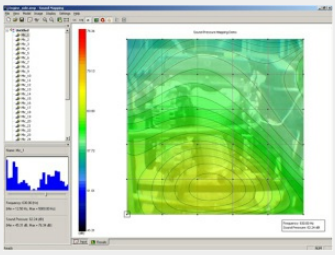

Figure 1

Generally speaking, an acoustic camera cannot measure below approximately 300Hz. At the upper end they sometimes reach 10kHz with some special models capable of 20kHz.

It is possible to get results of this form without a full blown acoustic camera. It is, in fact, possible with a microphone array or even several microphones moved from position to position. In this case a simple photographic image taken from a digital camera can be overlaid with the acoustic data, as shown in Figure 1.

Acoustic cameras have a particular spatial resolution, this is a factor of the area over which they are measuring. If you are far away from the test piece your get lower quality results than if you are closer. But when you are closer the camera can't 'see' the whole test piece. This actual resolution, the smoothness, of the sound map is normally a limitation of the algorithm used in the acoustic camera software.

An acoustic camera can quickly get from the data capture stage to a final result. The ability to complete the entire test at various engine speeds in a much shorter space of time can be an important factor and must be considered. The acoustic camera can take a very quick "snapshot". Furthermore, some acoustic cameras available in the marketplace do have order tracking functions. These might not be as well developed as with a more traditional NVH analysis system, but nonetheless they perform well enough for some users requirements.

Acoustic cameras use beam forming techniques. The sound pressure level distribution corresponding to the propagating direction can be estimated. This is therefore an approximated model of the sound field. It is possible to estimate the location of the sound sources from the measurement. For some case it does provide correct information, but, sometimes, due to limitations of the sound field conditions (e.g. reverberation), it does not.

SOUND INTENSITY PROBES

A sound intensity probe normally consists of two phase matched microphones mounted a certain pre-set distance apart.

The pre-set distance between the microphones is a factor of the wavelength of the sound waves that will be measured by the probe. Generally speaking the higher the frequency of interest, the smaller the gap between the two microphones. The rule of thumb is that the microphone pair should be able to sample different, but similar sections of the wave at the same time. This limits the frequencies that the classical sound intensity probe can measure.

The measurement of sound intensity is the measurement of sound power per unit area. Sound Intensity is an averaged, directional quantity that measures the rate of energy flowing through a specified unit area. Hence the two microphones facing each other. Sound intensity measurements are usually measured as Watts per square metre (W/m^2).

By comparing the differences between the two microphones, it is possible to calculate both the sound pressure and particle velocity between the two microphones. These two parameters are then multiplied together to calculate the sound intensity. Sound Intensity, therefore, has direction. A sound intensity probe measures the sound intensity traveling parallel to the probe. Therefore, sound originating in front of the probe will be measured as a positive intensity, but a sound from behind the probe will be negative, as shown in Figure 2.

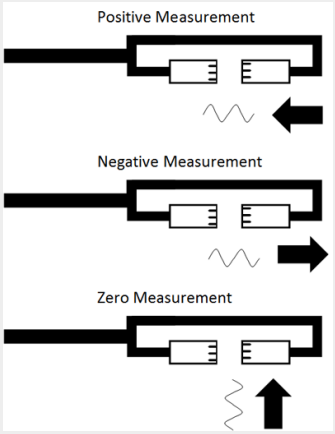

Figure 2

The sound intensity probe is often attached to a robotic probe measuring device. This allows the intensity probe to be moved to the exact same position time and again and usually very quickly. Most engineers agree that the robotic arm method would give the best results, but it is also perfectly possible to manually locate the sound intensity probe.

A usable measurement range of a sound intensity probe is normally limited to between 50Hz to 10kHz.

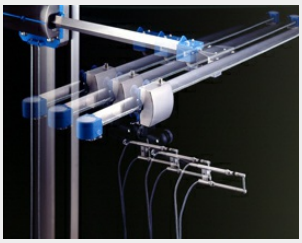

Figure 3

The robotic method is the best method for placing the microphone in the same position each time. However, it is only effective in the case of steadystate phenomena, such as an engine on a test bench, running at a particular speed. It's usually impractical, for economic reasons, to have multiple sound intensity probes so that dynamic phenomena can be measured. Figure 3 shows a sound intensity probe connected to a robot arm.

SUMMARY

Fundamentally, an acoustic camera is a tool used for locating sound sources or, more correctly, sound pressure sources. Sound pressure is the pressure level deviation from ambient caused by a sound wave passing through the medium.

The sound intensity probe is used to find the sound power per unit area. Sound power is a measure of energy over time.

These two devices are performing similar, but different tasks.

With this information in mind, an acoustic camera has advantages when evaluating both steadystate and non-steadystate phenomena. It can also provide results quickly. However, acoustic cameras are limited in frequency range and are further limited to only providing information about sound pressure levels.

The microphone array based solution has the same advantages and disadvantages as an acoustic camera, but often at a fraction of the cost.

A sound intensity measurement is a direct measurement, without the approximation and resolution issues sometimes associated with acoustics

cameras. But a sound intensity measurement is usually limited to steadystate phenomena, since practicality and economics often rule out the use of multiple probes. From a commercial point of view the sound intensity measure is generally the most expensive to perform.

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James Wren is an Application Engineer and the Sales Manager for Prosig Limited. James graduated from Portsmouth University in 2001, with a Masters degree in Electronic Engineering. He is a member of the Institution of Engineering and Technology. He has been involved with motorsport from a very early age with special interest in data acquisition. James is a founder member of the Dalmeny Racing team.

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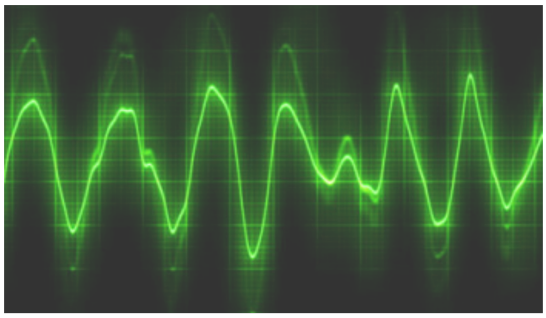

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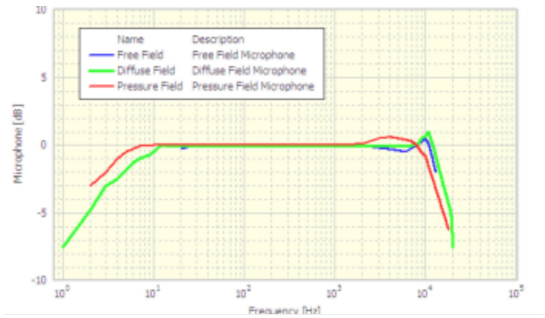

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4 COMMENTS

Alex | March 20, 2010 Reply

Hi James,
Noteworthy IMHO that intensity measurements drastically extend their usability to determine total sound power as they can get along with stationary external sound sources and normally do not require anechoic environments. Acoustic source localization, active, diffuse, reactive sound field identification is possible by its vector nature. Perhaps pp-intensity measurements are regarded "old-school", but like often: the right tool in the right hands can do magic, while the fancy high-tech approach can provide colorful misguidance. Science and art ?!

James Wren | March 22, 2010 Reply

Hi Alex,

Thanks for posting your comments on our blog.

Your points of view are interesting, thank you for sharing them with us and our readers.

I have to say I agree with your opinion about 'old-school' techniques, magic is possible as you say.

S.Sadasivan | June 12, 2010 Reply

nice write-up.
use of particle velocity sensors , for instance, microflown sensor, in direct measurements of partile veloity and thus intensity (microflown used in conjunction with a collocated microphone)could have been mentioned.

James Wren | June 15, 2010 Reply

Hello Mr Sadasivan,

Thank you for commenting on our blog.

You are right to bring this up, the particle velocity method of making these measurements is fairly new in terms of technologies, and I might say a rather good method as well.

Most people would still consider the classical microphone based solution when thinking of sound intensity. But the focus of the article was the acoustic camera and the intensity probe, not on types of sound intensity measuring device.

We are trying to make these tools clearer for people so that they may understand better the products and what they actually do.

We generally prefer not to mention suppliers of sensors by name as it would be unfair to the other suppliers.

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