SPECIAL FOCUS: **PROVING GROUNDS**

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INSIDE TRACK

Behind the scenes at BMW's brand-new Czech proving ground

AWARDS WINNERS

The results of this year's ATTI Awards are declared

"We use a 3D probe that is made up of three orthogonally positioned particle velocity sensors, one for each direction, together with an omnidirectional microphone," explains Lazarin. "An infrared stereo camera is then used to track reflective stickers that are positioned on a sphere that surrounds the probe. This allows the 3D coordinates to be tracked along with the sensor orientation. A user can simply scan an area of a vehicle and the data is processed to generate a 3D visualization of sound intensity, particle velocity and sound pressure distribution in a matter of minutes."

Microflown continues to advance its technologies by improving its software algorithms, sensing techniques, measurement methodologies and user experience, and by developing probes aimed at specific tasks. Lazarin cites VR and AR, gesture control, new and improved cameras and 3D tracking tech as new and interesting subjects to keep an eye on.

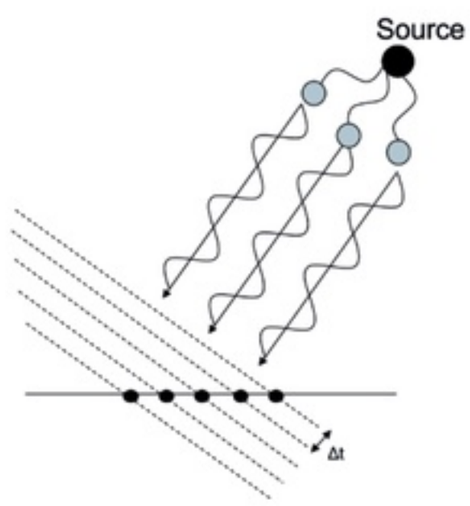
SOUND POWER

Sound pressure and particle velocity help to understand the behavior of sound as it is emitted from a source, but give little information on the source itself. When measuring sound pressure with the human ear or a microphone, the result depends on the distance from the source and the acoustic environment. Consequently, measuring sound pressure does not necessarily quantify how much noise a source actually makes. For that, sound power must be measured.

Sound power is the rate at which energy is radiated from a source per unit time. Sound pressure is the result of that radiating sound energy at a specific location. In other words, sound power is the cause and sound pressure is the effect. To calculate sound power, sound intensity needs to be measured first. This is the rate of energy flow through a unit area and is the product of particle velocity and sound pressure.

"Often the source you want to measure is surrounded by other sources of background noise. This makes it difficult to isolate the noise you are interested in to take accurate measurements," says Till Papenfus, senior technical expert at Head Acoustics. "To get around this problem, we measure sound intensity instead. To detect it, we use two microphones that face each other in a so-called intensity probe. Any noise coming in from the sides is ignored, while sound from behind the microphone is evaluated with negative signs."

In this way, Papenfus explains, an engineer can walk around a test object and add up all the noises with their direction of emission. "The ambient noise cancels out to zero, leaving the measurements for the noise from the test object that we are interested in," he says. "Once the sound intensity of a source has been measured, we can multiply this by an area to calculate sound power."



TOP: Using a food processor as an example, the HoloMetrix AR glasses display the next measurement point within a 3D grid. Once the probe has been used to take that measurement, a sound power color map is shown

ABOVE: When doing analysis with microphones, planar waves of a noise source reach each microphone at different times and this phase delay can be exploited to back-calculate the location of the source

The ISO 9614 standard specifies a precise method for measuring sound intensity either by scanning a test object or using a measurement grid of discrete points surrounding the object. The latter typically takes hours to set up and involves manually measuring out a grid, marking each measurement point with poles and constantly rechecking the measurement points. This time-consuming process not only requires significant resources but is also susceptible to human error.

To automate this process, Head Acoustics and HoloMetrix developed a technique that harnesses augmented reality. A virtual measurement grid is projected in three dimensions onto the screen of a pair of AR glasses. This is overlaid on the test object as well as the measurement probe, enabling the engineer to walk around the test object and visualize the exact measurement points required to meet ISO 9614.

"Engineers simply input information, such as the dimensions of the object and the relevant standard, and the software calculates the number of measurement points required and the distance between them, so no understanding of the standard is required," explains Papenfus.

When performing measurements, the AR glasses display a three-dimensional ball that represents the point where the next measurement needs to be taken. Once a point has been measured, a sound power color map is displayed, giving the user a graphical image as they progress through the measurement process.

"In automotive there has been a big shift from reducing the overall [vehicle] sound level to tuning the sound quality of a noise source," highlights Papenfus. "It's much easier to make a noise sound 'better' than to lower the overall level. This is why understanding not only the emitted noise source level but also the perceived quality of the emitted sound is becoming more of a priority in automotive." ❮

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Till Papenfus, senior technical expert, Head Acoustics