Seeing sound: Team develops noninvasive method to visualise sound propagation

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High-performance loudspeaker manufacturers have been able to improve sound quality dramatically over the years, but still face the issue of dead spots.

While HIFI loudspeakers can be designed to deliver the full frequency range of audible sound, it is difficult to achieve a smooth frequency output in all directions. Dead spots are caused by deconstructive interference as a result ofradiating sound waves overlapping and cancelling each other out. The biggest issue being where the sound is radiating from two or more sources, which commonly occurs in the mid-frequency ranges where both the 'woofer' and 'tweeter' loudspeaker cones are both active. This creates areas where the frequency response of the loudspeaker is less smooth, and sound quality is diminished.

Determining the nature of these dead spots has proven difficult until now. High accuracy acoustic measurements can be made using a microphone, but to build up a picture of the spatial distribution of the sound many point measurements are required within the 3D space. Manufacturers can conduct computer-aided simulations, but these can prove inaccurate to the actual loudspeaker performance through the variability of the manufacturing process.

Now The National Physical Laboratory (NPL), the UK's Measurement Institute, has developed a solution. The new laser-driven technique allows remote, non-invasive and rapid mapping of sound fields, which will provide loudspeaker manufacturers with reliable data on which to design their technology.

The technique builds on a piece of technology developed for the study of mechanical vibration; the laser vibrometer, and on research for its application to the 3D characterisation of underwater sonar arrays. This NPL work has shown that in air, the acousto-optic effect, the resulting optical phase change of light as it passes through an acoustic field, is significant enough to be detected. To measure the acoustic output from the loudspeaker, the laser is positioned to the side of the loudspeaker and is rapidly scanned through a series of points in front of the loudspeaker, being reflected back to the laser vibrometer by virtue of a retro-reflective mirror on the other side. By measuring the laser as it returns to its source, the technology can rapidly provide spatially distributed phase shift data, enabling an image, or video, of sound propagation around the source to be constructed.

Ian Butterworth, project lead at NPL, said: "This is a significant breakthrough for loudspeaker manufacturers. By having actual data to rely on, they will be able to better understand how different designs impact the loudspeaker's directionality, and design out the dead spots which could limit the quality of the loudspeaker."

"The main applications are likely to be for high-end in-home loudspeaker manufacturers who want their products to deliver the perfect surround sound experience, and outdoor loudspeaker manufacturers who want to eliminate the noticeable spatial changes in levels experienced at music festivals and other live events."

"We're now looking to conduct further studies, scanning larger areas with higher definition, to get a better picture of how sound is propagating away from these loudspeakers."

The measurement technique should ideally be performed in conditions that minimise sound reflection, such as NPL's hemi-anechoic chamber. However measurements can also be carried out outdoors given the natural hemi-anechoic nature of fields.

Provided by National Physical Laboratory

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