Targeted noise control

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In engineering applications, test environments are never ideal, given such variables as unknown background noise and interference signals, including sound reflections and reverberations. This reality makes the diagnosis of root causes of noise and vibrations of complex machines including automobiles very challenging. This paper presents a new technology that enables one to identify the most critical components of structural vibrations that are responsible for sound radiation, and leave the rest structural vibration intact. In this way, engineers can mitigate noise issues faster and easier. The underlying principles of this new technology include: 1) SODAR (SOnic Detection And Ranging); 2) HELS (Helmholtz Equation Least Squares) method; 3) F-VAC (Forced VibroAcoustic Component) analysis; and 4) AI (Artificial Intelligence) based deep learning and pattern recognition algorithms. SODAR can be likened to radar, except it is passive and utilizes sound waves to locate multiple sound sources simultaneously in 3D space. It enables one to pinpoint sound sources even in the presence of random background noise. The HELS method seeks optimal approximations of all vibroacoustic quantities, based on partial input data of the acoustic pressure and normal surface velocity. It enables one to visualize 3D sound field as well as vibration quantities on the surface of an arbitrarily shaped machine. The F-VAC analysis establishes the transfer functions that correlate the normal surface velocity to radiated acoustic pressure. It enables one to reveal the most critical component of structural vibrations responsible for sound radiation into 3D space. AI-based deep learning and pattern recognition algorithms enable one to eliminate background noise in the measured data and pick optimal reconstruction. Experimental validation results have demonstrated that using the targeted noise control, engineers can keep a comparable STL (Sound Transmission Loss) of the front dash panel of a F-150 pickup truck while reducing its weight by 30%.