

TPA innovations for strongly coupled systems

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Abstract

In a vehicle's development process, Transfer Path Analysis (TPA) is commonly used for identifying sound sources and their transmission to a receiver. Forces acting on the structure are the reason for the structure-borne sound share of the vehicle interior noise. In practice it is not possible, or too extensive, to measure operational forces directly. Instead, they are often calculated indirectly from accelerations and from additionally measured inertances. As the car body is a strongly coupled system, a force acting at one position results in accelerations throughout the structure. This crosstalk must be considered by using a dense inertance matrix consisting of the ratios between each force excitation and the accelerations at every sensor position. Then a matrix inversion is performed to solve the system of equations describing the coupling of the structure. For an engine TPA, this method has the disadvantage that it does not include the mounts, although their characteristics can have a major impact on the interior noise.

Another widely-used method predicts each body acceleration from the corresponding acceleration at the engine using the mount attenuation extracted from operational data. This has the advantage that active-side accelerations are less disturbed by other sources like tire-road noise or auxiliary components than passive-side accelerations. The resulting force is calculated without a matrix inversion, only considering the local body impedance. However, ignoring the crosstalk on the structure often leads to overestimating the force.

The Effective Mount Transfer Function method combines the advantages of matrix inversion and active-side accelerations as input signals. The transfer functions are calculated from operational data considering the crosstalk on the structure. Thus, active-side accelerations can be used for synthesis without overestimating the distinct sound shares. An extension of this method is presented that also takes the coupling of the spatial directions within one mount into account. Then for each mount an Effective Mount Transfer Matrix approach is used which improves the calculated operational forces for low frequencies.

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