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OPAX: A new transfer path analysis method based on parametric load models

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ABSTRACT

Since its first publication in the beginning of the 1980s, transfer path analysis (TPA) has evolved into a widely used tool for noise and vibration troubleshooting and internal load estimation, for single source and multivariate problems. One of the main bottlenecks preventing its even more widespread use in the vehicle development process is the test time needed to build the full data model, requiring not only in-operation tests but also extensive frequency response function (FRF) measurements.

As a consequence, several new approaches, such as operational TPA, have appeared over the past years attempting to circumvent this limitation. These methods attract quite some attention as they only require operational data measured at the path references and target locations. However, despite being time-efficient, these methods suffer from several limitations that can lead to incorrect path contribution interpretations and wrong engineering decisions.

Hence, a new TPA approach is proposed, providing a good compromise between path accuracy and measurement time. The method is referred to as OPAX as it essentially uses in-operation data complemented with a minimal set of extra tests with forced excitation. The key idea of OPAX is the use of parametric models for identifying the operational loads. This makes the method scalable, enabling the engineer to use a simple model based on a small amount of measurement data for quick troubleshooting or increase accuracy using a more complex model together with additional measurements.

1. Introduction

Transfer path analysis (TPA) is an experimental technique for identifying the vibro-acoustic transfer paths in a system. The energy transfer starts from the active system components that generate the structural and acoustic loads, and passes through the physical connections and along airborne pathways, to the response target locations in the passive system components. The acoustic and vibration responses at the target locations (e.g. interior noise, seat vibration, steering wheel vibration, etc.) are expressed as a sum of path contributions, each associated with an individual path and load. For example, for a target response $y_k(\omega)$ at point k, this is formulated in equation Eq. (1), where $y_{ik}(\omega)$ denotes the path contribution of path i, ω the frequency and n the number of paths:

$$y_k(\omega) = \sum_{i=1}^{n} y_{ki}(\omega) \tag{1}$$

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