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Separation of time variant vibration sources by short time coherent output power

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ABSTRACT

This effort describes the use of time variant coherence causality based analysis to separate the effects of nonstationary time variant vibration excitation sources. A time variant coherence function using the Short Time Fourier Transform (STFT) is first discussed. The concept of a time variant coherent output power for source separation of systems with time variant transfer functions is developed. A parametric study is performed to examine the coherent output power separation capabilities with respect to the data processing parameters. The study guided the selection of the time–frequency processing parameters judged to provide a suitable compromise between the time event localization and output amplitude source separation. The time variant coherent output power is then applied to separate the effects of the two possible excitation sources on the prototype vibration isolation floor. The application was a subscale prototype isolation floor for a proposed vibration sensitive equipment site adjacent to a busy freight rail line. The moving train created time variant transmission paths. As there was a direct line of sight between the prototype floor and the rail line there was an airborne acoustic excitation path in addition to a ground path. The short time coherent output power was applied to separate prototype isolation floor vibration into respective components related to the two candidate sources. The analysis and discussion of the results focuses upon the interpretation and issues in such a complicated realistic environment. Ultimately the application was successful providing an explanation as to why the observed vibration isolation was degraded at higher frequencies.

1. Introduction

Frequency domain input–output models have a long history of utilization for separation of the effects of multiple noise and vibration sources from a measured output [1–3]. The noise emanating from the various structural components of both industrial punch presses and closed die forging hammers from the respective striking operations have been evaluated [1,2]. The transfer path identification of airborne and engine noise in an automobile is discussed in [3]. The method is particularly well suited for applications when: (1) the sources are distinct; (2) readily identifiable, and (3) a signal representative of the sources' characteristics may be easily obtained. The method is less effective for systems comprised of distributed highly interrelated sources, such as an internal combustion engine.

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