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Structural sources identification through an inverse mid-high frequency energy method

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ABSTRACT

This paper is primarily focused on the identification of structural forces, with the objective of localizing forces injected into structures in the mid-high frequency range. An energy method, called the simplified energy method (MES), has already been introduced for the purpose of predicting an energy density distribution for structural acoustic problems in the mid-high frequency range. The present paper proposes using this same energy method to solve inverse structural problems. More specifically, the injected forces are to be estimated and localized through knowledge of a set of energy densities within the structure. The 2D formulation of this inverse approach, known as inverse MES (or IMES), is first expressed. Both the boundary and internal sources can then be detected by applying the proposed formulation. Numerical test results are processed using a 2D Kirchhoff plate, and a number of conclusions are also drawn regarding IMES capabilities. Moreover, this paper offers a numerical comparison with another energy-based method.

1. Introduction

The identification of force features that serve to excite structural components is a key concern in the field of structural engineering. The localization and quantification of input loads are of considerable interest; frequently, the direct measurement of sources proves quite complicated to perform. Indirect means for defining excitation often provides an effective alternative. A tremendous amount of work has been performed and published regarding this issue [1–11]. The problem being considered herein may also have applications in structural health monitoring. Damage, whose features often remain unknown, leads to changes in the vibration energy distribution of structural members. Both the magnitude and position detection of damage thus become key parameters.

In general, two approaches are available in the literature relative to input force identification aspects. The first has more or less been inspired by identification approaches for the black box-like behavior of dynamic systems, coupled with the introduction of estimation theories. As an example, in Refs. [1,2], the author uses an online recursive inverse method in order to estimate the input forces of beam and plate structures. The inverse method has been based on the Kalman filter plus a recursive least-squares algorithm that includes just a small number of measurement responses within the structure. Several types of input forces have been successfully identified. This method performs effectively in estimating the input forces of beam structural systems from noisy measurements. It has been shown [3] that a Kalman filter method may be

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