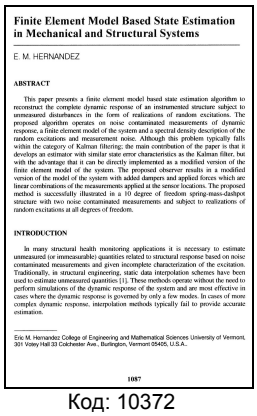

Finite Element Model Based State Estimation in Mechanical and Structural Systems

E. M. HERNANDEZ

ABSTRACT

This paper presents a finite element model based state estimation algorithm to reconstruct the complete dynamic response of an instrumented structure subject to unmeasured disturbances in the form of realizations of random excitations. The proposed algorithm operates on noise contaminated measurements of dynamic response, a finite element model of the system and a spectral density description of the random excitations and measurement noise. Although this problem typically falls within the category of Kalman filtering; the main contribution of the paper is that it develops an estimator with similar state error characteristics as the Kalman filter, but with the advantage that it can be directly implemented as a modified version of the finite element model of the system. The proposed observer results in a modified version of the model of the system with added dampers and applied forces which are linear combinations of the measurements applied at the sensor locations. The proposed method is successfully illustrated in a 10 degree of freedom spring-mass-dashpot structure with two noise contaminated measurements and subject to realizations of random excitations at all degrees of freedom.

INTRODUCTION

In many structural health monitoring applications it is necessary to estimate unmeasured (or immeasurable) quantities related to structural response based on noise contaminated measurements and given incomplete characterization of the excitation. Traditionally, in structural engineering, static data interpolation schemes have been used to estimate unmeasured quantities [1]. These methods operate without the need to perform simulations of the dynamic response of the system and are most effective in cases where the dynamic response is governed by only a few modes. In cases of more complex dynamic response, interpolation methods typically fail to provide accurate estimation.

Eric M. Hernandez College of Engineering and Mathematical Sciences University of Vermont, 301 Votey Hall 33 Colchester Ave., Burlington, Vermont 05405, U.S.A..

1057

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E.M. Hernandez

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Ключевые слова:

Содержание.