ACOUSTICS2008/536
High resolution modal analysis

Kerem Ege[a], Xavier Boutillon[a] and Bertrand David[b]
[a]Laboratoire de Mécanique des Solides, Ecole Polytechnique, 91128 Palaiseau Cedex, France
[b]Télécom Paristech (ENST) / TSI - CNRS LTCI, 46, rue Barrault, 75634 Paris Cedex 13, France

The Fourier-Transform-based traditional modal analysis techniques perform poorly when modal overlap η exceeds 30%, due to the ΔT.Δf limitation. In view of filling the gap between the low- and the high-frequency domains where modal analysis and statistical methods respectively apply, a technique based on the high resolution analysis algorithm ESPRIT (Roy & Kailath, IEEE Transactions on Acoustics Speech and Signal Processing, 37(7), 984-995, 1989) has been developed. A pulse-like force is repeatedly applied to the structure and the response is measured in a number of points. In each point, the impulse response of the structure is retrieved by deconvolving the pulse-like force and filtering the response with the result. In a second step, the number of modes in the reconstructed impulse response is evaluated by the novel procedure ESTER (Badeau et al., IEEE Transactions on Signal Processing, 54 (2), 450-458, 2006) and various preconditioning techniques are applied. The ESPRIT algorithm finally extracts the modal frequencies, damping factors, and complex amplitudes at each point. Two applications are presented: the separation of twin modes of a square plate (η=200%) and the partial modal analysis of a 1620 $\times$ 1000 $\times$ 5 mm aluminum plate up to a modal overlap η=70%.