A LITERATURE REVIEW FOR THE ANALYSIS OF STRUCTURED AND UNSTRUCTURED UNCERTAINTY EFFECTS ON VIBROACOUSTIC

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ABSTRACT

A better knowledge of the structural response of periodic structures can be achieved through the classification of possible uncertainty, to be included in the predictive models. Nowadays, the wave finite element approach is used for the simulation of periodic structures to reduce the computational cost. On the contrary, it introduces ahigher complexity in the model formulation. Recently, the spectral approach has shown its relevance in the uncertainty analysis of structures.

This paper presents the literature on uncertainty effect on vibroacoustic of periodic media. The present work is an initial literature study on available analytical and numerical approaches for capturing the parametric and nonparametric uncertainties.

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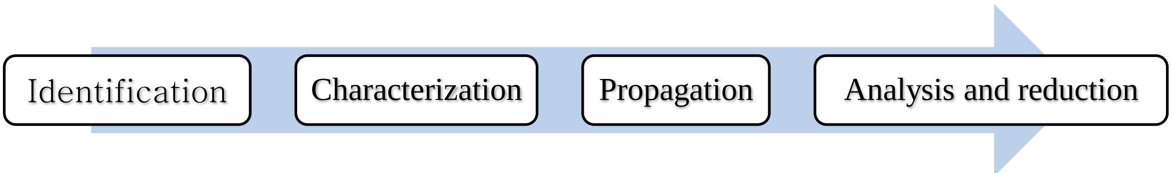
1. INTRODUCTION

The research community has been developing mathematical representation in the form of a mathematical model for a wide class of physical system to understand the process. Moreover, these models are being used to make the decision for design and manufacturing. It true that no mathematical model can be an ideal representation of physical system it is intended to capture because of the modeling assumption and limits of digital computing machines where numerical simulation performed. Although the digital computing is extending its wing in last decade, there are constraints of time and cost of computation. To the best of authors understanding, all derived model involve uncertainty and which are bound to come. The reason is how to model is represented, and how the physical system behaves in reality, there is always the issue of the goodness of fit.

The vibroacoustic performance and dynamics of the structure areimportant subjects in the area of aeronautic, transport, energy and space. To meet the regulatory compliance and user requirement, the designer accounts for variation in the input parameter at the design phase. For example, in the space industry designers consider the uncertainty in the system parameter to ensure that the during launch and orbital operation the vibration level are in a range that is acceptable. Which open plethora of opportunity for considering the effect of uncertainty with theaim to improve and develop the model for reliable and safe design. Keeping the view this paper summaries uncertainty quantification, uncertainty classification, modeling of uncertainty system and the most commonly used technique to analyses uncertainty in the low to high-frequency model prediction.

2. UNCERTAINTY QUANTIFICATION:

In general term the uncertainty quantification involves the five steps:



1. Identification: Finding the source and location of uncertainties in the system. In reality many sources of uncertainty such asuncertainties due to variabilities in the design parameter values, environmental condition, initial conditions, boundary conditions, imprecise and simplified physics, missing physics, model implementation, numerical errors and most importantly due to lack of unavailability of sufficient data
2. Characterization: Finding the form they are available. Mostly, the parametric uncertainty is characterized and defined in the form of probability distribution and intervals bound. Whereas nonparametric uncertainty so-called model uncertainties can have their form of uncertainties.
3. Propagation: Understanding how uncertainties are transmitting and spreading in the model and finding a relation between parameter uncertainties and response of the model.
4. Analysis and reduction: Establishing the relation between the uncertainty and its influence on the system response and reasoning of the same. Once it is done, what corrective measure can be taken to have the reliability of the original system.

3. MODELING OF UNCERTAINTY SYSTEM:

The uncertainty in structural response such as frequency response function, natural frequency, and mode shape are the result of propagation of uncertainty (may be parametrical or non-parametric). To capture the response with uncertainty in models and parameters, various research group spread across the world using various approach to modeling the uncertainty. The basic uncertainty block of technique/tool available for uncertainty modeling in the structural dynamics[1-7] can be drawn (Figure 1).

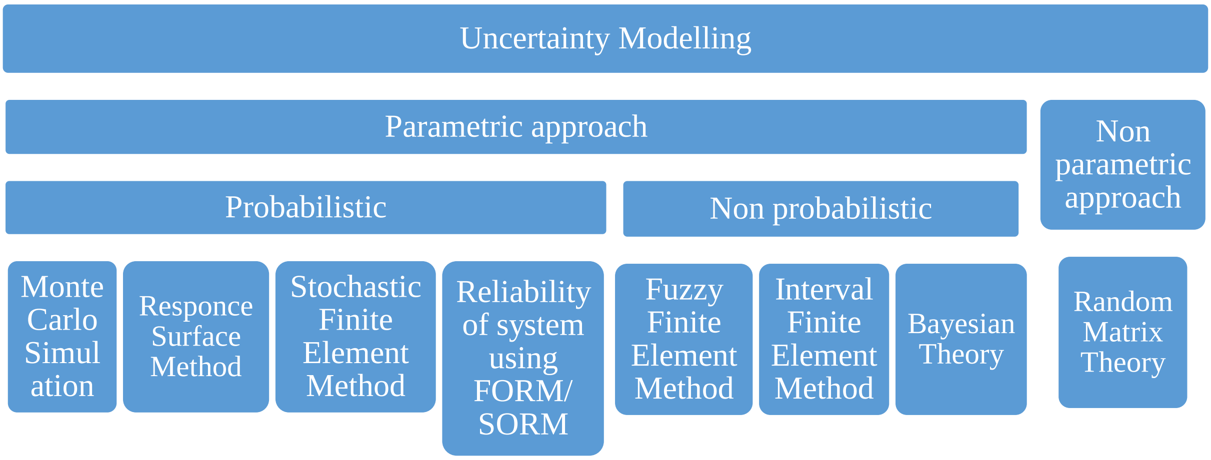


Figure 1. Uncertainty modeling approaches

4. VIBROACOUSTIC ANALYSIS WITH UNCERTAINTY

In thevibroacousticproblems, the interaction between a solid and fluid field in the form of vibration and sound happen respectively. The use of the numerical method for the numerical modeling and simulation varies, and itdepends on the frequency range of interest.

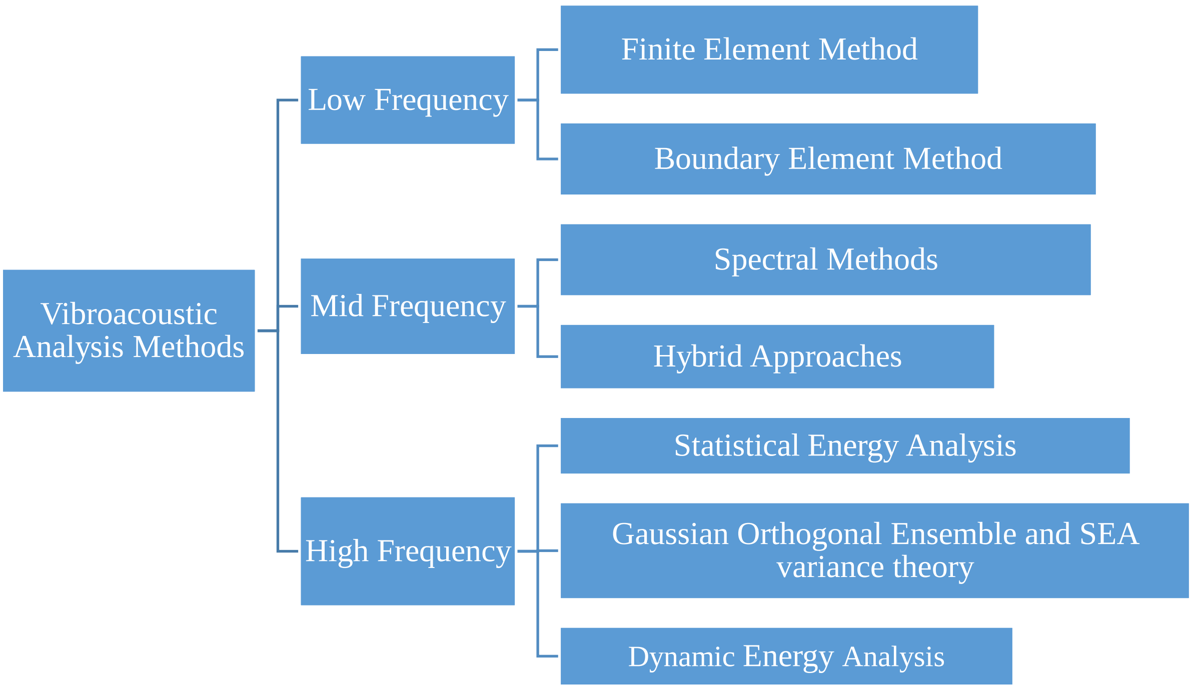


Figure 2.Vibroacoustic analysis methods without uncertainty

A graphical representation is drawn (Figure 2) of the technique available for vibroacousticsimulation[8-11].When uncertainty introduced in the modeling and simulation of vibroacoustic periodic media the low-frequency domain is unaffected (assumption), the high-frequency domain is modeled using statistical energy approach which can accommodate uncertainty. However mid frequency domain is in question. A tree is drawn (Figure 3) as based on available literature.

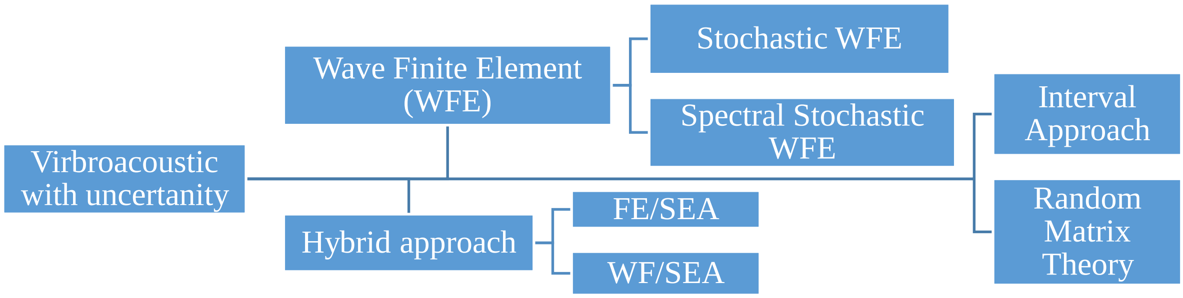


Figure 3.Vibroacousticanalysis methods with uncertainty

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