A fast frequency sweep approach with a priori choice of Padé approximants and control of their interval of convergence

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ABSTRACT

Detailed analyses involving structural-acoustic finite element models with three-dimensional modelling of porous media may become rapidly computationally costly [1], particularly when put into perspective with the computational resources generally allocated. Such problems therefore require efficient tools to be further developed, and several contributions have been made in this sense in the recent years [2-4]. In this work, an original approach including the use of Padé approximants is proposed in order to allow the efficient handling of large-sized multiphysics problems, particularly in the context where multiple frequency response estimations may be required, e.g. for topology optimization, multiple load cases analysis, etc.

One particular emphasis of the work that will be presented in the full paper and at the conference, concerns the a priori choice of the Padé approximants and their associated range of convergence. These are two crucial aspects of their use for a fast frequency sweep methodology ultimately leading to an effective solution of the coupled finite element problems of interest. In recent contributions by the authors [3,5], this challenge was partially addressed by using a posteriori error estimators within a globally adaptive methodology, in an attempt to have the approximants match anticipated intervals of convergence, thus reducing the number of these approximants and their associated computational burden. Other methods in the literature have successfully included such a posteriori error estimators in order to control the Padé-based reconstruction of the solution. In the present contribution, an approach is proposed in order to determine, a priori, both the choice of Padé approximants and their associated range of convergence, thus enabling an optimal use of these approximants in order to cover the entire frequency range of interest.

The paper will present the theoretical details of this methodology and demonstrate its validation on both conservative acoustic problems and dissipative coupled structural-acoustic problems including poroelastic media. Accuracy, efficiency and practical conclusions on the proposed method will also be discussed.

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