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IMPULSE BASED SUBSTRUCTURING AS PARADIGM FOR COUPLED ANALYSIS OF DYNAMIC COMPONENTS

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In several engineering applications components are developed by different groups but the dynamic behavior needs to be analyzed for the entire assembly. Often the analysis is then performed in a substructured way, meaning that a macro element is generated to characterize each component at its interface. Assembling the macro-elements then provides the full model. In structural dynamics, the interface behavior of a component is typically represented by reduced mass, damping and stiffness matrices obtained by approximating the dynamics by interface modes and a reduced number of local vibration modes. A well-known approach is the Craig-Bampton method, used as a standard technique over the last 40 years [1].

Such component synthesis methods have the disadvantage that the dynamics can be accurately represented only for a limited frequency band unless many modes are included. This is especially a drawback when shock-like excitations are present.

Recently a different approach to substructuring has been proposed, where substructures are no longer characterized by their matrices, but rather by the impulse response on their interface [2]. Also similar ideas were proposed earlier (e.g. [3]), the Impulse Based Substructuring (IBS) method proposed in [2] provides a systematic way to couple components through their interface using Impulse Response Functions obtained analytically, experimentally or numerically. The method expresses the interface problem in a dual form meaning that the interface forces are computed in order to enforce the interface compatibility conditions. The time response is then computed by applying a convolution product (Duhamel's integral) in each substructure.

When excitations are present on internal degrees of freedom of a component they can be represented either as equivalent forces or displacements on the interface, or included by considering the impulse responses at their point of application. Further, when non-linear components are present they can be coupled in an time-integration scheme to substructures represented by impulse response. Finally, to reduce the cost incurred by the discrete convolution products, we will indicate how truncation of the impulse response can significantly speed up the computation.

The method will be illustrated on a simple academic example as well as for the analysis of a simple wind turbine model on an off-shore support structure.

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