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Parametric model order reduction for dynamic analysis and optimal design of nearly periodic structures

Subject: Nearly periodic structures can be seen as periodic structures that include cells with small parametric variations. These cells can represent any 2D or 3D substructures subject to geometric changes (mesh morphing) that may concern, for instance, bladed disks composed of sectors of different shapes (mistuning), or metamaterial plates including different resonant cells. When properly designed, such nearly periodic structures can reveal interesting properties like energy localization effect, wave beaming, robustness... Geometric changes of the cells can be understood as geometric variability or disorder. The key idea here is to seek the appropriate ''levels of disorder" of the cells to optimize the properties of nearly periodic structures. Hence, geometric changes of the cells could be governed by random variables of different dispersions, i.e., randomness which is likely to vary between the cells. To carry out optimization procedures at affordable computational times, a parametric model reduction approach developed by the supervisor of the PhD proposal will be used. The main steps of the approach involve (1) interpolating reduced matrices of substructures (cells) and (2) reducing the number of interface degrees of freedom between the substructures. Besides several improvements of this approach have been recently proposed for a better accuracy at high frequencies. Then this PhD intends to develop original optimization procedures for the design of nearly periodic structures. In this framework, data driven approaches (e.g., physics informed neural networks) could be investigated to help develop the reduced models of nearly periodic structures and conduct the optimization procedures.

Keywords: Nearly periodic structures, geometric changes, parametric model order reduction.

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