The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

A stochastic interface scheme for mechanical substructuring problems with large interfaces: an application in electronics

F. Naets[1,2], **S. Neeckx**[1,2]

[1] Department of Mechanical Engineering, KU Leuven, frank.naets@kuleuven.be
[2] DMMS Lab, Flanders Make at KU Leuven

Keywords: *Substructuring, model order reduction, electronics simulation*

In automotive applications, electronics, chips on printed circuit boards (PCB), are subject to severe thermal cycles and mechanical vibrations. Detailed finite element models of these systems are essential to assess the durability during the design phase [1]. Unfortunately, the intricate nature of the chips and their housing implies that very fine meshes are required, which leads to extremely large models (easily up to 10^6 degrees-of-freedom (DOFs)) for the full electronic systems.

Conventional substructuring approaches are inadequate to accelerate these analyses as these systems typically contain large interface between the different components [2]. In order to mitigate this issue we propose a two-stage approach to accelerate the analysis of these large-interface substructuring problems:

- Each substructure with n DOFs is subject to a set of randomly distributed loads over the interface. A proper orthogonal decomposition is performed on the resulting responses in order to extract a small number m of dominant deformation modes for each substructure. These are the stochastic interface modes $\mathbf{V}^{SIM} \in \mathbb{R}^{n \times m}$.
- These SIMs lead to non-conforming displacement fields between the substructures. To enable the coupling we propose to employ a dual formulation with an internal penalty description, instead of the regular Lagrange multiplier approach.

Through this scheme we can efficiently set up reduced order models for the substructures, and couple them back together in a flexible fashion. This approach is validated on an industrial scale mesh and shows accurate results for a dramatically reduced computational load with respect to the full order model.

Acknowledgements Internal Funds KU Leuven and the Flanders Innovation & Entrepreneurship Agency (within the COMPAS project) are acknowledged for their support.

REFERENCES

[1] Numerical Analysis Guidelines for Microelectronics Packaging Design and Reliability, IPC/JEDEC-9301: 2018.

[2] C. Farhat and M. Geradin, On a component mode synthesis method and its application to incompatible substructures. *Comput. & Struct.*, 51 (5), pp. 459–473, 1994.