Chair of Computational Modeling and Simulation
TUM School of Engineering and Design
Technical University of Munich

Modeling:
Mathematics:
Programming:
Science:

Software Lab:

Parametric Model Order Reduction for structures with arbitrary underlying meshes

Description

For several applications, like for example parametric Model Order Reduction, it is necessary to compare the displacement field of a structure for different realizations of the parameters of the structure. This can easily be done if the topology of the mesh stays the same. However, when using geometric parameters, it might not be advisable or even not possible to have the same topology of the mesh for different realizations of the parameters. The reason is that the mesh would have to move with the structure, which can result in extremely distorted meshes. Furthermore, automatic meshing implemented in commercial preprocessing software can also lead to different mesh topologies for different realizations of the parameters.
Therefore, methods are required that allow obtaining the displacement field of an arbitrary mesh in terms of a reference mesh. In the scope of these methods, the geometrically different structures are often transformed to a reference shape and afterward the displacement of the individual structures can be evaluated for the reference mesh. This can either be done by making use of the shape functions of the FE code or by interpolation [1,2]. If the displacement fields of the different structures are then represented with respect to the same reference mesh, a comparison can be performed. The objective of this project is to implement these methods for the chair's in-house FEM code and compare them with each other.

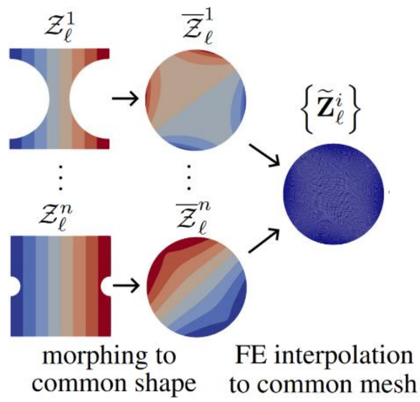

Fig 1: Morphing of the mesh to the unit disk and interpolation to a reference mesh, Figure adapted from [1]

Task

- get familiar with methods to evaluate the displacement field of an arbitrary mesh at a reference mesh
- implement the methods investigated in the literature review
- apply them within the framework of (parametric) Model Order Reduction

Supervisor

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References

[1] Casenave, Fabien, Brian Staber, and Xavier Roynard. "MMGP: a Mesh Morphing Gaussian Process-based machine learning method for regression of physical problems under non-parameterized geometrical variability." arXiv preprint arXiv:2305.12871 (2023).

[2] Kracker, David, et al. "Automatic analysis of crash simulations with dimensionality reduction algorithms such as PCA and t-SNE." 16th International LS-DYNA Users Conference. 2020.