Chair of Computational Modeling and Simulation
TUM School of Engineering and Design
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Model order reduction for bolted joints by hyper-reduction and machine learning

Project Characteristics

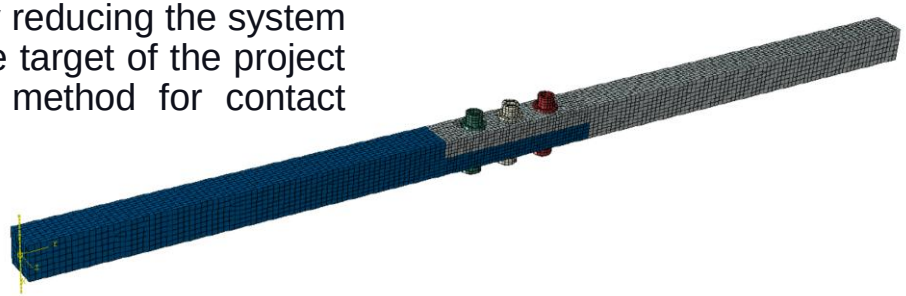
Modeling:
Mathematics:
Programming:
Science:

Description

Tasks such as uncertainty quantification or optimization often require running multiple finite element simulations, which are usually very computationally expensive [1]. Hyperreduction methods such as Energy Conserving Sampling and Weighting (ECSW) and Discrete Empirical Interpolation (DEIM) can simplify the nonlinear finite element models, reducing complexity and speeding up these analyses [2]. Integrating Convolutional Autoencoders (CAE) can further improve performance by reducing the system to a lower dimensional space, capturing spatial patterns and nonlinearities [3]. The target of the project is to assess the feasibility of the presented Model Order Reduction (MOR) method for contact nonlinearity problems.

Task

- Literature review on Hyperreduction and Autoencoder algorithms
- Modelling of bolted connection with FEM
- Implementation of MOR workflow with Hyperreduction and CAE



Finite element model of the Brake-Reuss beam. [4]

[1] Lacayo, R., Pesaresi, L., Groß, J., Fochler, D., Armand, J., Salles, L., ... & Brake, M. (2019). Nonlinear modeling of structures with bolted joints: a comparison of two approaches based on a time-domain and frequency-domain solver. Mechanical Systems and Signal Processing, 114, 413-438.
[2] M. Lengger, K. Willner, *Reduced order modeling for bolted structures. Proceedings of ISMA 2022.*
[3] Fresca, S., Dede', L., & Manzoni, A. (2021). A comprehensive deep learning-based approach to reduced order modeling of nonlinear time-dependent parametrized PDEs. *Journal of Scientific Computing*, *87*, 1-36.
[4] Gross, J., Armand, J., Lacayo, R. M., Reuß, P., Salles, L., Schwingshackl, C. W., ... & Kuether, R. J. (2016). A numerical round robin for the prediction of the dynamics of jointed structures. In *Dynamics of Coupled Structures, Volume 4: Proceedings of the 34th IMAC, A Conference and Exposition on Structural Dynamics 2016* (pp. 195-211). Springer International Publishing.

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