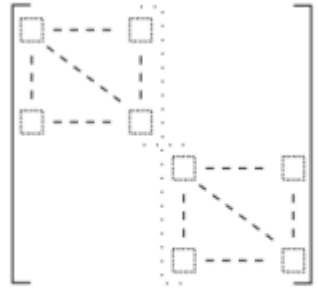
Chair of Computational Modeling and Simulation
TUM School of Engineering and Design
Technical University of Munich

Optimized Data Structure for Discontinuous Finite Cell Method

Project Characteristics

Modeling:
Mathematics:
Programming:
Science:

Finite Cell Method is a p-version FEM method in which the elements do not conform to the physical boundaries of the domain [1,2]. Currently, we are developing a new version of FCM in which the elements are connected to each other through the internal fluxes. Therefore, they can have different orders, and different material properties. This will increase the flexibility of FCM in modelling problems with moving boundaries, such as additive or subtractive manufacturing.
A group of 2-3 students are expected to work on improving the data structure for the exchange of information on the edges shared between cells.

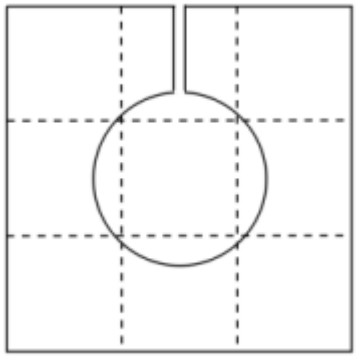


$$\begin{bmatrix} k^1 & 0 \\ 0 & k^2 \end{bmatrix} \begin{Bmatrix} u^1 \\ u^2 \end{Bmatrix} - [P] \begin{Bmatrix} u^1 \\ u^2 \end{Bmatrix} = \begin{Bmatrix} f^1 \\ f^2 \end{Bmatrix}$$

- *Objective: Develop and implement an optimal data structure to improve memory usage, computational efficiency, and scalability for large-scale DFCM simulations.*
- *Expected Outcome: A modular, scalable, and efficient data management system that supports large-scale DFCM simulations.*

Tasks

• Analyze the current data structure for nodes, elements, and connectivity to identify bottlenecks.
• Explore and implement modern data structures (e.g., sparse matrices, octrees, or hash maps) for handling large, structured/non-conforming grids.
• Integrate parallelization techniques where applicable to improve performance.
• Test the optimized data structures with both 2D and 3D problems to ensure scalability and accuracy.



1. Parvizian, J., Düster, A. & Rank, E. Finite cell method. Comput Mech 41, 121–133 (2007).
2. A. Düster, J. Parvizian, Z. Yang, E. Rank, The finite cell method for three-dimensional problems of solid mechanics, Computer Methods in Applied Mechanics and Engineering (2008).