Transient problems with the Finite Cell Method

In contrast to standard finite elements, fictitious domain methods do not require a boundary-fitted mesh. Instead, they embed structures of arbitrarily complex geometry in a domain of simple shape. The Finite Cell Method (FCM) [1,2] is a high-order approximation scheme that follows the fictitious domain idea. The method is independent of the applied approximation basis and exploits adaptive integration to accurately capture the true physical geometry.

So far the Finite Cell Method has been successfully applied to various problems from engineering and science such as solid and thin-walled structures, elasto-plasticity, advection-diffusion and thermo-elasticity. Other fields like transient problems haven't yet gained much attention and will be in the focus of this software lab project including the implementation of a Newmark algorithm [3] and testing various benchmark problems from the field of elastodynamics.

The project will consist of the following stages:

- getting familiar with the principles of the Finite Cell Method
- modelling, implementation and testing of stationary problems to get into the fictitious domain approach
- extension of the existing 2D framework (C++ implementation) by a Newmark algorithm
- modelling, implementation and analysis of various benchmark problems to verify the implementation and to study the overall performance of the Finite Cell Method for elastodynamic problems

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References

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[2] M. Ruess, D. Tal, N. Trabelsi, Z. Yosibash, E. Rank (2011). The finite cell method for bone simulations: Verification and validation. DOI: 10.1007/s10237-011-0322-2 *Biomechanics and Modeling in Mechanobiology*.

[3] K.-J. Bathe. Finite Element Procedures, Prentice-Hall, Inc., Upper Saddle River 1996