Chair for Computation in Engineering
Department of Geo, Civil and Environmental Engineering
Technical University of Munich

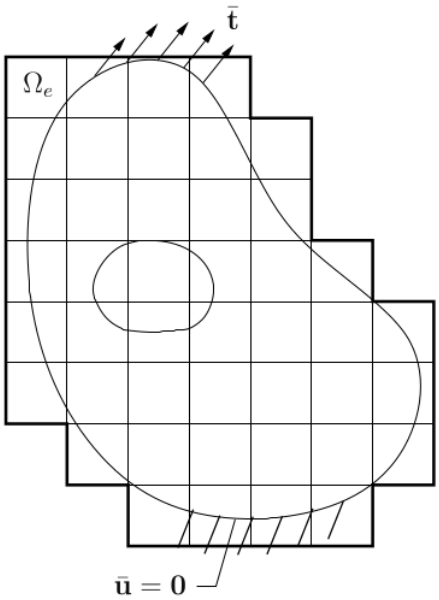
Modeling: ★☆☆☆☆
Mathematics: ★★★☆☆
Programming: ★★★★★
Science: ★★☆☆☆

Software Lab:

Implementation of the finite cell method (FCM) into a commercial finite element software

Setting

The finite element method is the standard tool for solving mechanical problems. While with increased hardware performance the solution times have decreased drastically, meshing the computational geometry still requires manual work. Although automatic mesh generators today produce reasonable results even for complex geometries, problems arise especially if the input geometry is flawed. Healing such geometries is a tedious work and cannot be automatized in many cases.



This problem can be overcome by immersed methods, such as the finite cell method. Here, the physical domain is embedded in a simple Cartesian mesh. The original geometry is recovered at the integration level using adaptive methods, which are easy to implement for Cartesian grids. It is often used together with high-order elements, making it very accurate (even for non-smooth problems) and robust against geometric distortions [1, 2].

Introduced originally in 2007, the method has gained more and more recognition in science and industry. The research on the finite cell method has continued since and many extensions to various problems have been proposed. The goal of this project is to provide an implementation of the method into a commercial finite element software. To meet the demand for high reliability of computations in engineering industry, the project strongly emphasized robustness and simplicity.

Tasks

- Obtain a fundamental understanding of the finite cell method and the complications it brings
- Identify a FE software that provides a suitable interface for user elements (allowing an adaptive integration technique), preprocessing of the geometry and post-processing of the solution
- Sketch a work-flow according to the requirements posed by the chosen commercial software
- Implement this design and verify it by computing common benchmark problems

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References

[1] A. Düster, E. Rank, B. Szabó, The p-Version of the Finite Element and Finite Cell Methods, Encyclopedia of Computational Mechanics Second Edition, September 2017

[2] A. Düster, J. Parvizian, Z. Yang and E. Rank, The finite cell method for three-dimensional problems of solid mechanics, Computer Methods in Applied Mechanics and Engineering, pp. 45-48, 15 August 2008.