FEm2m
Finite Elements - made to measure

by Franz-Theo Suttmeier

Standard FE-Software very often is not adequate for more and more challenging applications in science and industry requiring guaranteed accuracy for certain quantities.
We propose to create FE-packages *made to measure*. On the one hand one can use existing software, especially for pre- and postprocessing, e.g., mesh generation and graphical output. On the other hand individual FE-implementations are required.

Overview and Key Features

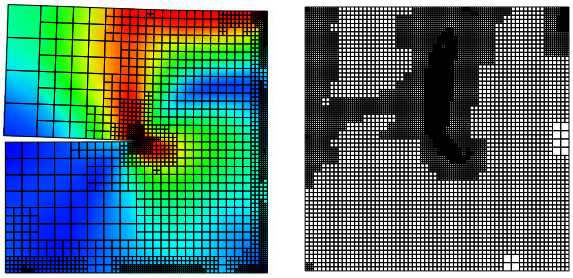
- simulation for a wide class of different problems
- problem-dependent discretisation
- family of standard and non-standard FE-basis functions
- reliable *a posteriori* error prediction
- optimal mesh refinement with respect to the quantity of interrest
- zoo of solvers
- object-oriented design allows for the analysis of algorithms and user-defined enhancements

Simulations made to measure

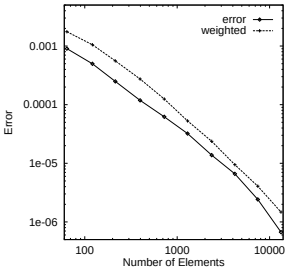
Based on experiences collected within the last 10 years at the universities of Bonn, Heidelberg and Dortmund, we support various applications in different areas.

- continuum mechanics
  - nonlinear materials
  - micro structural analysis
  - contact problems
- fluid mechanics
  - incompressible fluids
  - low Mach number flow problems
- electromagnetism
- multiphysics
  - fluid structure interaction
  - electro magnetical forming

Besides the free choice of the topic, corresponding adequate discretisation and related solvers, one main aspect in our approaches are adaptive methods. We construct optimal refined meshes with respect to the user-specified quantity of interest.

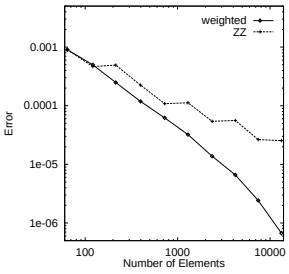


Example: Opening at the tip of the crack of a workpiece



Reliability: New techniques allow for the reliable prediction (*weighted* in picture) of the error (*error* in picture).

Efficiency: Our methods (*weighted*) for adaptive mesh refinement significantly reduce the amount for memory and computation time compared to standard procedures (*ZZ*) to obtain the same error tolerance.



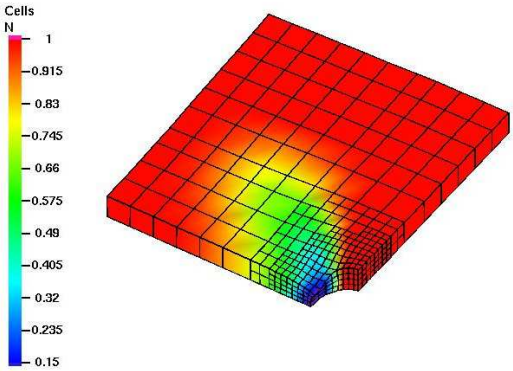
Remark: Number of cells measures computational costs.

FEm2m-packages

We provide packages for standard applications in different areas. On the one hand, these implementations serve as examples for illustrating our FE-concepts. On the other hand they build the basis for new FE-code made to measure.

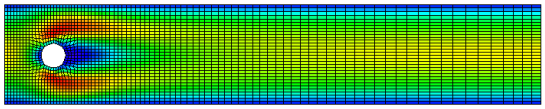
Package CM3D

3D-FE-Simulation for problems in continuum mechanics.



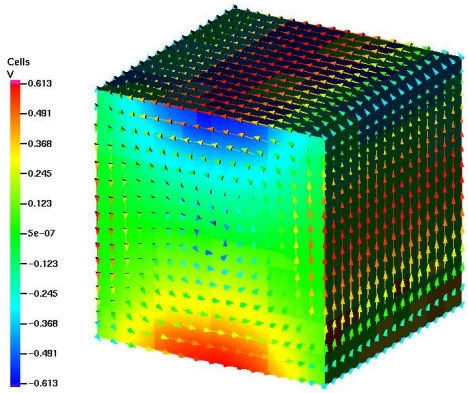
Package FM3D

3D-FE-Simulation for problems in fluid mechanics.



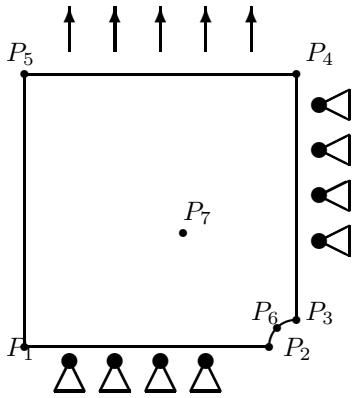
Package MF3D

3D-FE-Simulation of magnetic field problems



Application of CM3D

We apply our adaptive approach to a standard benchmark problem. A geometrically two-dimensional square disc with a hole is subjected to a constant boundary traction acting upon two opposite sides. In the 2-dimensional case we use the plane-strain approximation and assume perfectly plastic material behavior.



Values of the stresses in point P_7 under cycling loading are evaluated. A *reference solution*, where about 500.000 degrees of freedom (DOF) were needed to guarentee an error below one percent, was produed on a parallel computer. Our adaptive discretisation controlling the errors in time and space only reqires about 12.000 DOF on a PC to reach the prescribed accuracy.

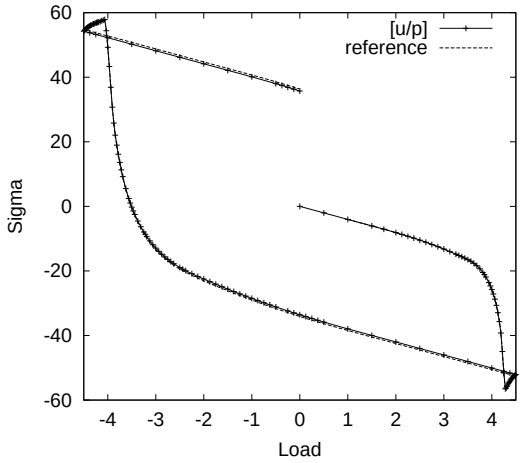


Figure 1: Plot of the reference solution (500.000 DOF) and the one obtained by our adaptive scheme (12.000 DOF).

System Requirements

All systems with g++-compiler. Especially our implementations can be run for Windows 95/98/NT and Linux.

Contact

Prof Dr. Franz-Theo Suttmeier
Fachbereich Mathematik
Walter-Flex-Str. 3
57068 Siegen
Tel.: 0271 740-3617
info@fem2m.de
http://www.fem2m.de