Chair for Computation in Engineering
Prof. Dr.rer.nat. Ernst Rank
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Modeling: ★★★★☆
Mathematics: ★★★☆☆
Programming: ★★★★★

Software Lab:

Acoustics meets bones

Setting

Acoustics is more than the generation and propagation of sound in a gas. For example in seismology, simulations of the acoustic wave equation are used for inferring the origin of earthquakes. Similar methods are used in civil engineering for non-destructive testing of materials and for surveying defects in a structure.

Within this project acoustic theory shall be applied to the CT scan of a human femur. The regular Cartesian grid of these scans allows solving the governing equation with finite-difference methods. Challenges are the heterogeneous distribution of material properties (cf. Figure 1) and the considerably large number of time steps needed in combination with the already large 3D grid of sizes up to $512\,x\,512\,x\,256 = 2^{26}$ points. In order to run such a simulation within a feasible time frame, the software developed with C++ is to be parallelized with OpenMP and shall be executed on the cluster of the Chair for Computation in Engineering.

Literature on the topic and introductory tutorials will be provided.

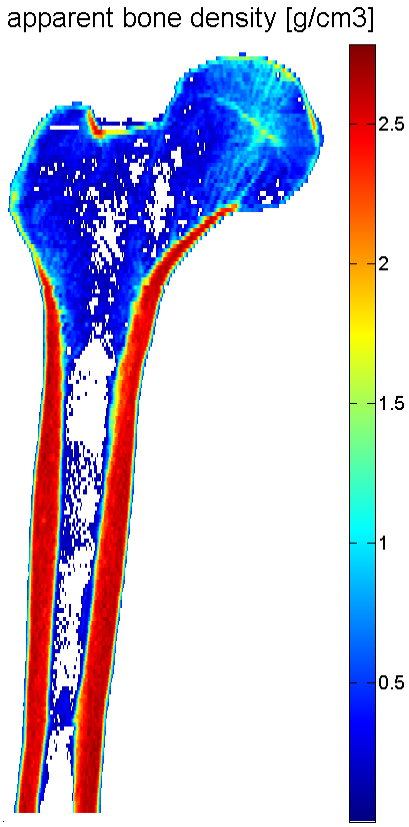

Figure 1: Single slice of a CT scan of a human femur

Task

Starting from scratch your tasks will be to

- Derive the governing equations of acoustics for an isotropic but heterogeneous elastic (solid) continuum and discretize them with the finite difference method
- Implement the scheme in C++ and test the software on a standard workstation – first in 2D than in 3D.
- Parallelize your program with OpenMP and test it on the chair's cluster

Supervisors

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