Enhancement of a preprocessor for the simulation of human bones

Medical imaging techniques like quantitative computer tomography (qCT) can be used in combination with the Finite Cell Method (FCM) for predicting the mechanical response of human bones [1]. Such an endeavor normally requires the extraction of a bone's geometry from the qCT scan via a costly segmentation and meshing procedure. This effort can be decreased tremendously with the recently developed FCM, which takes advantage of the voxel-based structure of qCT data.
Setting up simulation models for the FCM still necessitates some pre-processing of the data, which is mainly extracting a volume of interest and defining Neumann and Dirichlet boundary conditions. While the first has been part of the previous Software Lab your task will be to enhance the existing code by the latter functionality.

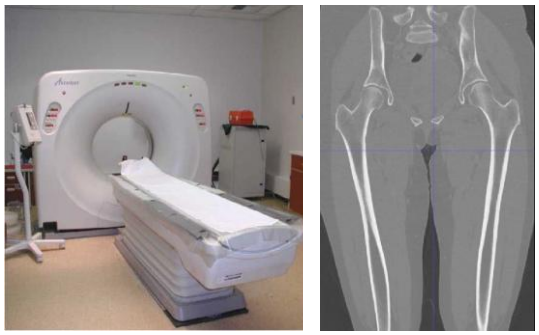

Fig 1: qCT machine and scan of a human

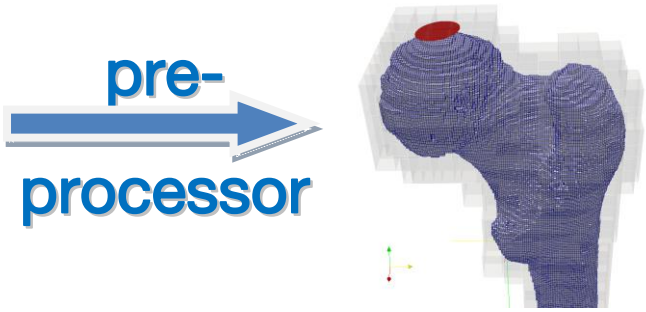

Fig 2: femur model

Even though the actual simulation of human bones is not part of this project, students will become acquainted with the theory behind it. Having the simulation as application in mind, the main task will be to develop a feature for an already existing pre-processor written in C++. This feature shall allow the user to interactively create various surface meshes within the GUI of the program, which specify surface loads and supporting areas in a physiological reasonable manner. In the end, an export-function for the boundary conditions shall complete the pre-processor.

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References

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