Topic 1:
Algorithms for reduction of CT datasets

Numerical schemes like the finite element method (FEM) or the finite cell method (FCM) are powerful tools for orthopaedic biomechanics. To analyse patient-specific data, computational models based on computed tomography (CT) are derived. These computational models are of increasing interest since they support the interpretation of clinical results, the design of orthopaedic implants or they support to investigate the risk of femoral neck fracture. Besides the development of realistic material models describing the mechanical behaviour of bones, the fully automatic derivation of efficient computational models based on CT datasets is still a topic of ongoing research. Major difficulties in the creation of a computational model based on CT scans are related to the huge amount of data and the difficult meshing procedure which should be, of course, fully automatic. The FCM [1] is a new numerical method which has been developed in order to ease the process of meshing of complicated geometrical models defined by, for example, CT datasets.

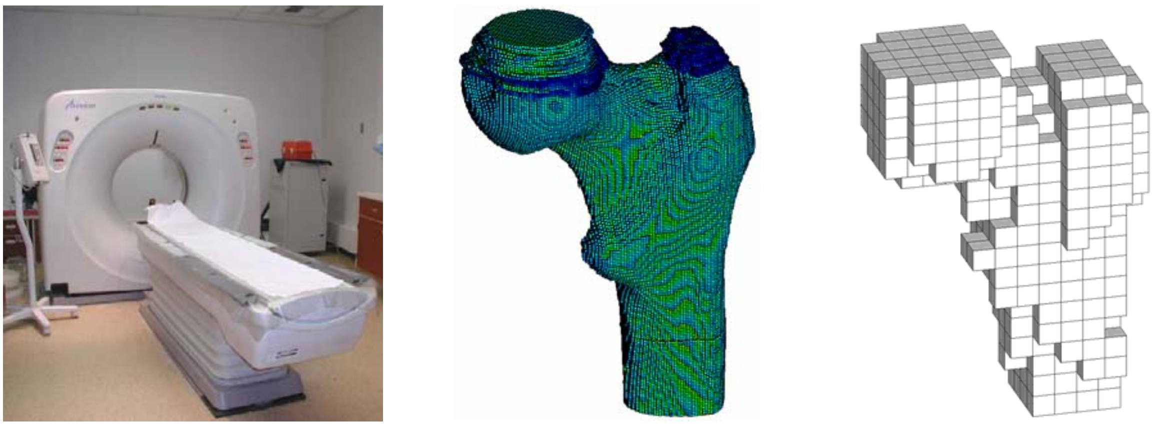

Figure 1: CT scan of a proximal femur

To further enhance the FCM with respect to the application to patient-specific data, algorithms for reduction of CT datasets need to be developed, since the amount of memory needed to handle the datasets may become a limiting factor. Furthermore it is possible to significantly improve the computational efficiency of the FCM by carrying out a carefully developed data reduction. The algorithm to be developed for data reduction should be such that the loss of information, i.e. the error can be controlled in an adaptive manner. One possibility could be to first carry out a "coarsening" of the voxel model defined by the CT scans, see Figure 1, right-hand side. In a second step the dataset can then be developed into piecewise polynomials defined on the individual cells of the coarsened model. To obtain the polynomial description a least squares fit [2,3] combined with an adaptive procedure controlling the loss of information should be implemented. Existing software to support this approach will be made available.

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References

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[2] D. Yang. *C++ and object-oriented numeric programming*, Springer, 2001.

[3] W.H. Press, S.A. Teukolsky, W.T. Vetterling, B.P. Flannery. *Numerical Recipes in C++ - The Art of Scientific Computing*, Cambridge University Press, 2002.