

Mathematical Modelling and Simulation in Facial Surgery

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Abstract: Since late 1999, the CAS group at ZIB (CAS: computer assisted surgery) has been working on operation planning for maxillo-facial surgery in close cooperation with clinical surgeons, in the beginning with Zeilhofer and Sader (then TU Munich, now U Basel and U Frankfurt), today with a number of further clinics. Within the integrated software environment AMIRA the group has realized

(a) the construction of 3D virtual patients from real patients out of detailed medical imaging data (stacks of CT or MRT files), which involves the efficient generation of 3D tetrahedral grids (only few details to be given);

(b) off-line operation planning tools to be used within clinics or within teleconferences between clinics and ZIB, which involve a huge amount of software engineering (details to be nearly skipped);

(c) preoperative prediction of the postoperative facial appearance of patients, which involves the fast numerical solution of partial differential equations for nonlinear elasticity by an affine conjugate adaptive multilevel Newton-CCG method where the nonlinearity is due to geometry and to Ogden material laws.

(d) modelling and preoperative simulation of postoperative facial expressions (like a smile), which involves a detailed muscle model, the so-called 'virtual fiber' model.

The talk will include detailed clinically relevant results for individual patients that have been operated on the basis of our plans and comparisons of the real operation outcome with the computed virtual patient predictions.

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