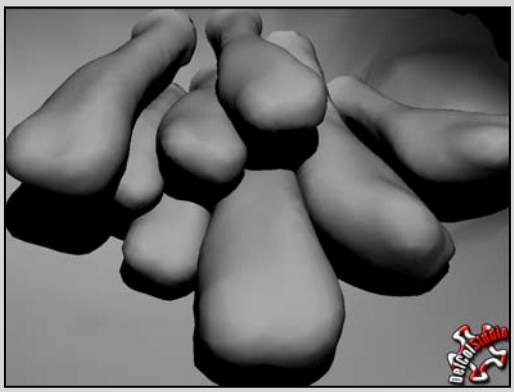
Computational Medicine

Marc Gissler Markus Becker Rüdiger Schmedding
Marc Metzger Matthias Teschner

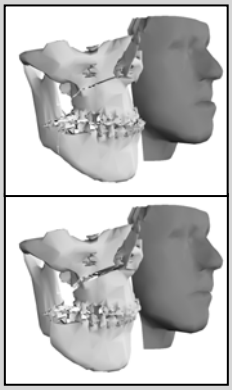
University of Freiburg

Motivation

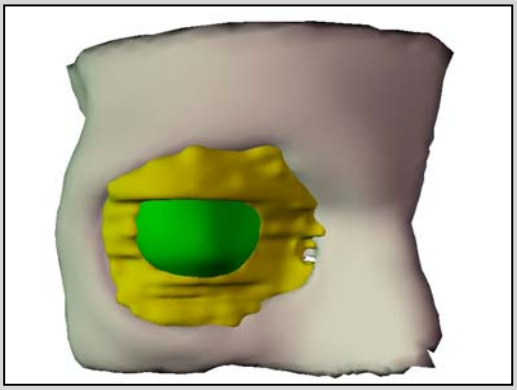
- **interactive trainings systems** to support the education of surgeons
- **pre-operative planning systems** to improve accuracy and reliability of the planning process
- **intra-operative navigation support** to address intra-operative changes of pre-operative data



hysteroscopy simulation



cranio-maxillofacial surgery



orbital reconstruction

Methods

Object representation

- triangulated surfaces from tomographic data
- tetrahedral meshes from pseudo volumes

Deformable modeling

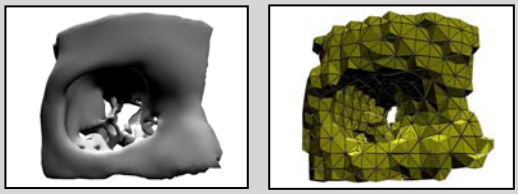
- accurate **Finite Element models** using a co-rotational linear approach, or
- efficient and robust **geometrically motivated models** that preserve volumes, surfaces or distances

Collision handling

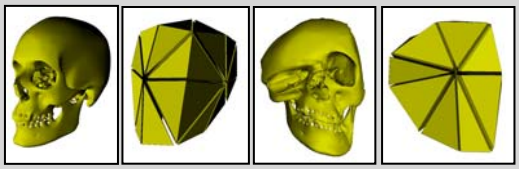
- adaptive spatial subdivision for the efficient **detection of interferences** between deformable objects
- consistent penetration depths for the computation of **appropriate response forces** for deformable objects

Cutting

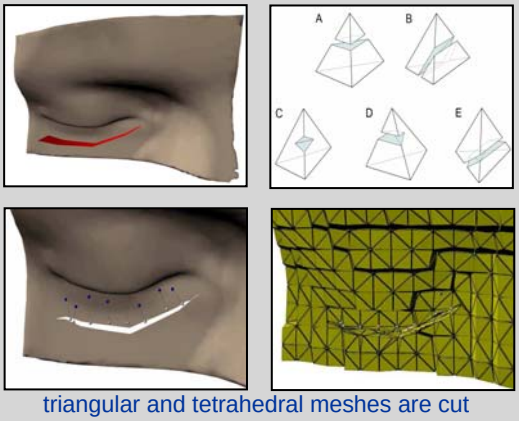
- predefined efficient **constraints** are dissolved, or
- **hybrid cutting algorithm** for static and dynamic cuts
- cutting of triangular and the tetrahedral meshes
- re-adjustment of geometric and physical properties



surface and volume representations of a bone structure



transfer of the deformations from the coarse tetrahedral mesh onto the triangular mesh



triangular and tetrahedral meshes are cut along the red cutting surface

Computational Medicine - Applications

Marc Gissler Markus Becker Rüdiger Schmedding
Marc Metzger Matthias Teschner

University of Freiburg

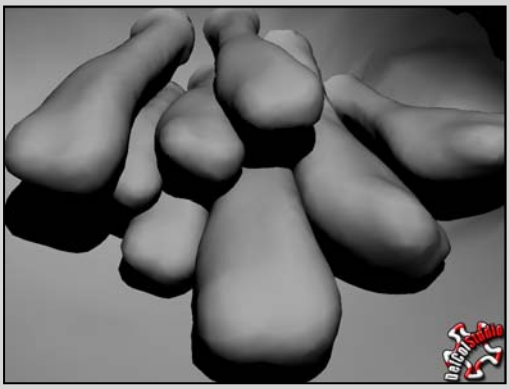
Hysteroscopy simulation

Goals

- development of an **interactive training system**
- simulation of the removal of polyps inside the uterine cavity

Features

- interactivity
- various deformable interacting anatomical models
- cutting of polyps and uterus



polyps inside the uterine cavity

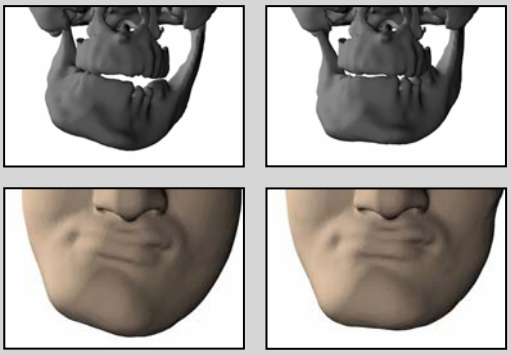
Cranio-maxillofacial surgery

Goals

- development of a **pre-operative planning system**
- prediction of soft-tissue deformations due to bone realignments

Features

- co-rotational FEM for soft-tissue deformations
- two-way coupling of soft tissue and bone structures with local constraints
- sliding contact of bone and soft tissue



A rigid-body transform is applied to the bone structure.
The impact on the soft tissue is computed.

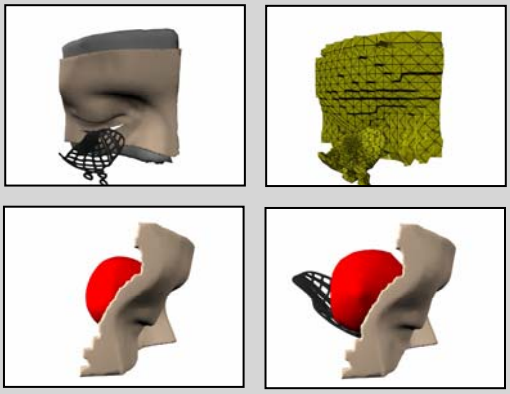
Orbital reconstruction

Goals

- **support of intra-operative navigation**
- soft-tissue simulation due to the insertion of a preformed orbital implant
- prediction of the post-operative eye bulb position based on the orbital floor reconstruction
- determination of a possible overcorrection

Features

- soft-tissue cutting to prepare the implant insertion
- simulation of the interaction between implant, bone structure, muscles, fat tissue and eye bulb



insertion of the orbital implant
and its impact on the eye bulb position