Computer Assisted Image Processing and Navigation System for Orthopedic-Trauma Surgery

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Surgery of fractured bones is often a very complex problem. The fixation of these bones has to be designed very carefully. This is the reason why trauma surgeons try to build a geometrical and mechanical model of the treated bone. Following the simulation and analysis of the behavior of the bone, surgeons can test several virtual surgical methods on the virtual bone and they can find the optimal treatment for the patient. A new computer software has been developed by our team, it is called MedEdit.

The system has three main parts: The first part builds geometrical model of the treated bone. CT scans were used for this procedure. Then the segmentation of the bone parts is followed. A 3D structure is constructed from the segmented model. Usually we get a very complex geometrical model so we use some kind of mesh simplification algorithm to eliminate the complexity of the surface. In the third part we created a medical planner where a surgeon can test several surgical ways. We implemented some kind of 3D editing functions like implant insertion, boring, slicing. We show our geometrical model generated from the patient CT scans and the medical planner user interface which is easy to use for the surgeon.

The system works in an experimental way. It is able to perform all tasks, but there are still points where some user interaction is needed. For example, the segmentation of the bones starts by setting seed points manually, its result should be checked by the surgeon. The communication with FEA (Finite Element Analysis) is not automatic; it is solved by a session file. The system has been implemented and worked. Generally, it is able to create the geometric and mechanical models in ca. 5 minutes including the user interactions. The FEA takes roughly 6 minutes for a pelvis 3D volume study (on a 2 GHz computer with 1,5 GB memory). Our stress results seem to match the clinical expectations, although quantitative tests and measurements are still to be done.

We plan to extend our system with the ability to help the surgeon during the operation to find the right points and angles. With three or more cameras installed in the operating theater we could identify some special marked points and give real-time information where and in which angle the surgeon has to insert the implants.