curac2004
3. Jahrestagung der Deutschen Gesellschaft für Computer- und Roboterassistierte Chirurgie e.V.

Vergleich eines semi-automatischen Segmentierungsalgorithmus mit der manuellen Segmentierung des Mastoids für die Planung einer vollständigen Mastoidektomie

Comparison of a semi-automatic segmentation algorithm and manual segmentation of the mastoid bone for the planning of a complete mastoidectomy

Erwin Schwaderer[1], F. Dammann[2], Z. Salah[3], M. Kastner[2], D. Malthan[4], M.M. Maassen[5], D. Bartz[3]

[1]Universitätsklinikum Tübingen
Abt.f. Radiologische Diagnostik
[2]Abt. f. Radiologische Diagnostik, Universitätsklinikum Tübingen
[3]WSI/GRIS - VCM, Universität Tübingen
[4]Fraunhofer-Institut für Produktionstechnik und Automatisierung IPA, Stuttgart
[5]Hals-, Nasen- und Ohrenklinik, Universitätsklinikum Tübingen

Purpose

For the CT based planning of a robot assisted complete mastoidectomy, a segmentation of the mastoid bone is required. This process is very time consuming when done manually. In this contribution we compared manual segmentation with a semi-automatic algorithm for complete mastoidectomy in terms of time and safety issues. As a result a requirements specification for further development of the semi-automatic algorithm should be derived.

Material and Methods:

15 CT datasets from patients who planned to receive a fully implantable hearing aid were used for simulation. A manual excavation of the mastoid bone was performed by an experienced radiologist using a medical workstation (EasyVision, Philips, Best, Netherlands). Our proprietary semi-automatic algorithm was applied on the same preoperative datasets. In a preprocessing step, it removed the spongious bone in the mastoid by an improved implementation of morphological erosion. Remaining structures were resolved by filtering the image with Recursive Gaussian Smoothing. Then the mastoid hull was extracted by a sequence of intensity-threshold based region growing steps: First, a region growing filter was applied to segment the soft tissue region that surrounds most

of the mastoid. A second filter was used to segment the bones. The results of these two filters were combined with the original input image to produce a temporary image, from which a final region growing filter extracted the mastoid. Unfortunately the mastoid segmentation filter may still leak out through false connections due to partial volume effects of the CT scan, resulting in oversegmented regions. These regions are detected by a semi-automatic editor and interactively selected and removed. Finally an opening of the skull was interactively chosen as an entrance to the cavity.
The segmentations were compared slicewise by loading both of them as an overlay into the same initial patient dataset (Fig.1-2; green: outer contour of manual segmentation; red: automatic segmentation). Since they originate from the same CT dataset, a registration was not necessary. Additionally a three dimensional comparison of the segmentations was performed.

Results

The semi-automatic algorithm reduced the segmentation time from approximately 45 minutes for the manual segmentation to less than 10 minutes. It identified the area of the spongious bone quite reliably. In some cases the bony lamina of the mastoid adjacent to the dura was eroded (Fig. 2; arrow) and safety critical regions including the sinus sigmoideus and the inner ear were not respected. Hence, additional manual post editing was necessary, that partially consumed the speedup primarily provided by the automatic segmentation. Safety margins for anatomically critical regions have to be adressed in the further development of the algorithm to reduce the amount of necessary manual post editing.

Conclusion←

The first clinical evaluation of our semi-automatic algorithm showed a significant acceleration of the tedious manual segmentation of the mastoid bone. Manual post editing was still necessary but less time consuming than the purely manual approach. Safety aspects have to be adressed in the future development to facilitate the final control by the physician.