Teaching tool for advanced visualization of temporal bone structures by fusion of $\mu$CT and CT scan images

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Teaching tool for advanced visualization of temporal bone structures by fusion of μCT and CT scan images

Main goal
Improve the understanding of human temporal bone computed tomography (CT) scans based on semi-automatically segmented microcomputed tomography (μCT).

Introduction
The three-dimensional ear anatomy is complex and challenging to interpret in CT scans because small structures are partially visible. Histological slices provide complementary high-resolution information, but may lead to geometrical distortions of the anatomy during preparation. Conversely, μCT preserves the shape.

3D images acquisition and segmentation
- Five freshly cadaveric pairs of temporal bones
- Acquisition of CT (General Electric; Light Speed VTC 64) and a μCT (General Electric; eXplore spectCT) images
- Seed-based segmentation of every reliable anatomical structures on CT or μCT

CT µCT CT µCT

CT µCT CT µCT

Reliable anatomical structures
- Cortical and trabecular layers of the entire temporal bone
- Vestibular labyrinth with the scala tympani and vestibuli
- Osseous and their ligaments
- Tympanic membrane
- Middle ear muscles and tendons
- Internal carotid artery and the sigmoidae sinus
- Different branches of the vestibular nerve
- Facial nerve and the chorda tympani

Rigid registration of μCT and CT
- First, rough point-based registration using anatomical landmarks
- Second, automatic rigid registration using a block matching framework

References

Results
High resolution structures are fused and visualized on corresponding CT images. This experience significantly improves the visual recognition and spatial understanding of partially visible structures (e.g. tympanic scala, facial nerve and chorda tympani) in CT images.

Conclusion
Geometrically accurate temporal bone reconstructions provide an advanced teaching tool for medical students and cochlear implant surgeons. The understanding of spatial relationship between anatomical structures as well as the virtual exploration of surgical approaches is greatly facilitated.

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