



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

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Main goal

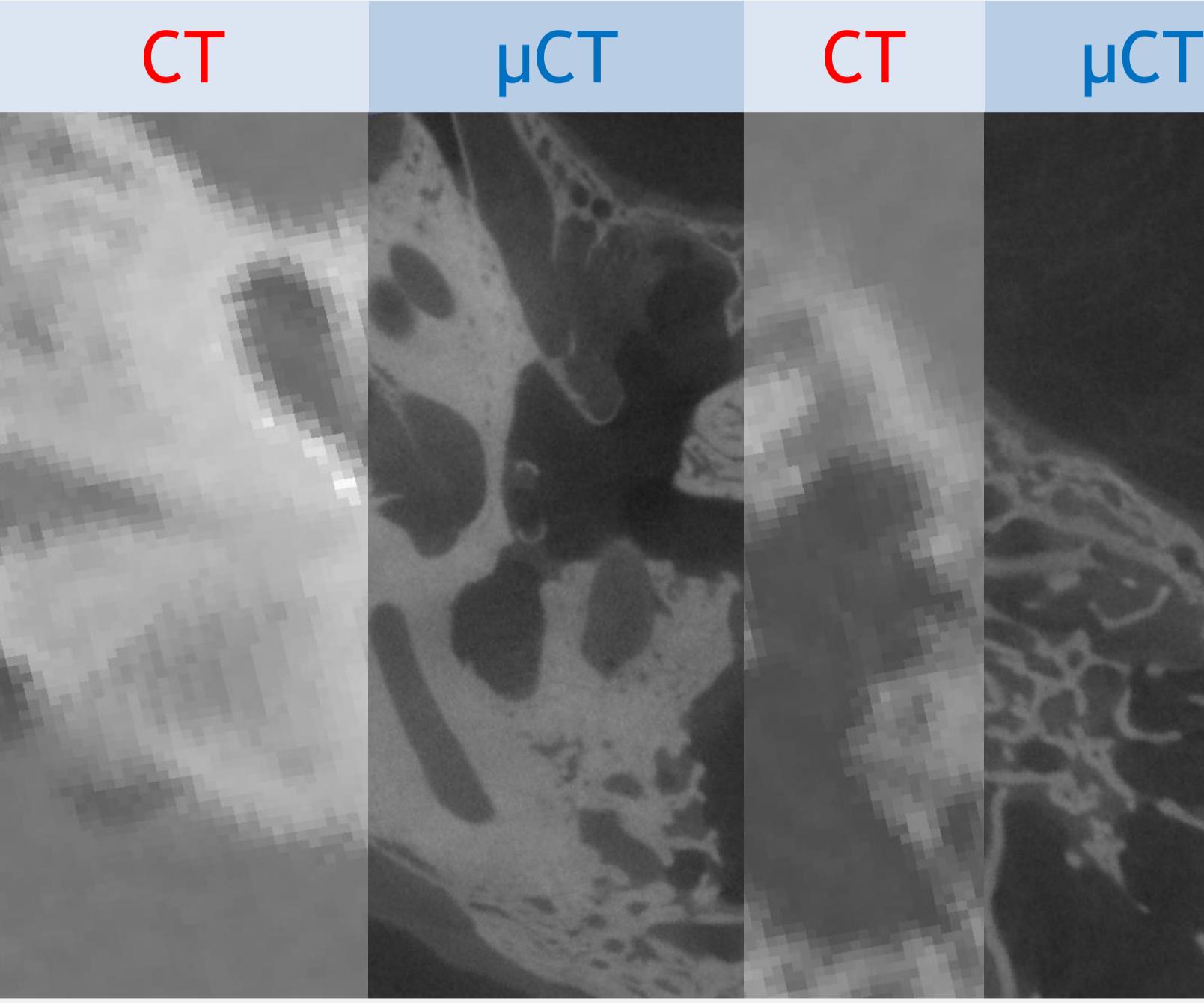
Improve the understanding of human temporal bone computed tomography (CT) scans based on semi-automatically segmented microcomputed tomography (μ CT).

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, μ CT 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 speCZT) images
 - Seed-based segmentation of every reliable anatomical structures on CT or µCT



Rigid registration of μ CT and CT

- First, rough point-based registration using anatomical landmarks¹
 - Second, automatic rigid registration using a block matching framework²

Referen

- ¹ Umeyama, S.: Least-squares estimation of transformation parameters between two point patterns. IEEE Trans. Pattern Anal. Mach. Intell. 13, 376-380 (1991).

² Ourselin, S., Roche, A., Prima, S., Ayache, N.: Block Matching : A General Framework to Improve Robustness of Rigid Registration of Medical Images. Med. Image Comput. Comput. Interv. 557-566 (2000).

Reliable anatomical structures

- cortical and trabecular layers of the entire temporal bone
 - vestibular labyrinth with the scalae tympani and vestibul
 - ossicles and their ligaments
 - tympanic membrane
 - middle ear muscles and tendons
 - internal carotid artery and the sigmoide sinus
 - different branches of the vestibular nerve
 - facial nerve and the chorda tympani

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.

| N° | Structure |
|----|----------------------------------|
| 1 | pyramidal eminence |
| 2 | sinus tympani |
| 3 | posterior tympanic sinus |
| 4 | chordal ridge |
| 5 | excavated lateral tympanic sinus |
| 6 | styloid eminence |
| 7 | chordal eminence |
| 8 | chorda tympani |
| 9 | cochlea |
| 10 | stapes |
| 11 | lateral sinus |
| 12 | superior semi-circular canal |
| 13 | facial nerve |
| 14 | internal carotid artery |
| 15 | tympanic membrane |
| 16 | scala tympani |
| 17 | CT slice |
| 18 | sickle crest |
| 19 | superior vestibular nerve area |
| 20 | inferior vestibular nerve area |
| 21 | posterior ampullary nerve |
| 22 | cochlear nerve area |
| 23 | stapes muscle |
| 24 | tensor tympani muscle |
| 25 | posterior ligament of incus |
| 26 | superior ligament of incus |
| 27 | superior ligament of malleus |
| 28 | anterior ligament of malleus |

