Experimental Audiology Lab
Klinikum rechts der Isar
Technical University of Munich

Master's Thesis: Open-Source Image Processing Tool for Cochlear Implantation Research

Background

Cochlear implants (CIs) are neuroprosthetic devices for individuals with hearing loss. Accurate knowledge of CI electrode positioning can enhance patient outcomes. Currently, the gold standard for assessing electrode placement is through computed-tomography (CT) imaging. Proprietary software tools are available to analyze and annotate inner ear structures and CI electrode positions. However, their accessibility is limited, and no tailored open-source alternatives currently exist. To advance innovation in the field and raise awareness toward image-guided approaches in the hearing research community, an open-source image processing tool that can be freely shared would be highly beneficial. Our lab has previously developed a prototype of such a tool, built within a widely used open-source medical visualization and multi-planar reconstruction software. However, further development is needed to enhance the tool's functionality, robustness, and usability.

Aim

In this project, you will develop and test an open-source image processing tool designed to analyze and annotate the cochlea using a diverse dataset of pre- and postoperative CT scans from multiple clinical centers.

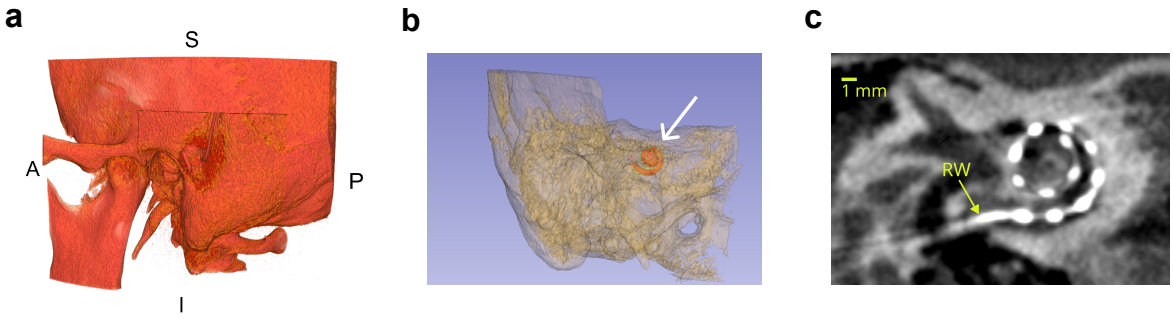

Abbildung 1: (a) 3D visualization of co-registered pre- and postoperative Computed Tomography (CT) scans of the temporal bone. (b) Position of the segmented cochlea within the temporal bone, indicated by the white array. (c) Postoperative CT slice of the cochlear basal turn with cochlear implant electrodes. A: anterior, S: superior, P: posterior, I: inferior, RW: round window.

Your tasks

- Basic research (10%): Conduct a literature review on current image processing methods used for cochlear implantation. Identify desirable techniques that are not yet publicly available for processing CT scans of the inner ear. Assess the relevance and feasibility of approaches such as anatomical segmentation and automated identification of cochlear implant electrodes using the existing software prototype. Explore the potential to extract additional image-based features related to the cochlea, adjacent anatomical structures, or the implant itself.
- Tool development and experiments (70%): Based on the literature research and your ideas, you will develop and implement methods for annotating the cochlea and determining cochlear implant positioning. A key focus will be on integrating an existing pipeline for extracting anatomical characteristics into the current image-processing tool. The developed tool will be applied to a dataset of approximately 50 pre- and postoperative CT scans of the temporal bone. Ground-truth annotations from proprietary software will serve as a benchmark for evaluation.
- Results analysis (20%): Evaluate the accuracy of the annotations produced by your tool in comparison to those from the proprietary software. Perform statistical analyses of the extracted image features to assess consistency and reliability.

Your profile

- Master's student in the field of Computer Science, Biomedical Engineering, Electrical Engineering, or a similar area
- Intermediate Python programming knowledge
- Strong motivation and scientific curiosity
- Experience with Computed Tomography scans as a bonus

We offer

- Opportunity to engage in innovative clinical research as part of a young, welcoming, and interdisciplinary team
- Collaboration with experts from the Bern University Hospital, Switzerland
- Continuous supervision and mentorship on site for the whole duration of the project
- Workspace at the Klinikum rechts der Isar at Max-Weber-Platz with good accessibility by public transportation

Application

If you're interested in the topic, don't hesitate to send us an email with your application documents (e.g., CV and transcript of records).

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