Optical Coherence Tomography Imaging of the Inner Ear: A Feasability Study With Implications for Cochlear Implantation

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Seminar Presentation
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Presentation Outline

- Project Overview and Paper Selection
- Problem
- Theory
- Experiment
- Assessment
Project Overview

• Cochlear Implant
  • Used to restore function to the cochlea
  • Standard practice is manual insertion via forceps

• Project goals
  • Image the cochlea using OCT Imaging
  • Create Models from OCT images
  • Create Virtual Fixtures for use in inserting electrode array
  • Enact virtual fixtures on steady-hand robot and insert implant
Paper Selection

• Paper Topic
  • Cochlear Implantation using OCT Feasibility study
  • Efficacy of OCT Imaging on temporal bone

• Feasibility of Project
  • Strength of OCT signal
  • Possibility of contour creation

• Accuracy of Constructed Models
  • Precision of contours detected in OCT scans
  • Precision of constructed model
Problem

• Current practice
  • Manual insertion via forceps
  • Relies on marker a fixed distance from implant tip

• Issues with standard practice
  • Low visibility
  • Precision needed
  • Hand tremors
  • Possibility of inaccurate placement
Theory

- Interferometry principle of light
  - Beams of light travel different distances
  - Phase difference indicates distance

- OCT setup
  - Beam from light source split
  - One beam hits reference mirror
  - Other bounces off of temporal bone
  - Recombined at detector
  - Phase difference analyzed

Courtesy Lin et al
Experimental Setup

- Rotating OCT probe developed
  - Scans are taken as probe rotates in cochlea
  - For each rotation, the scans are fit to a polar graph
  - These b-scans are taken at multiple depths

Courtesy Lin et al
Experimental Results

- Rotating OCT probe mouse test
  - Probe inserted into mouse tympanic cavity
  - B-scans imaged at 1 Hz
- Rotating OCT probe human test
  - Probe inserted into cadaveric cochlea
  - B-scans imaged at 3.1 Hz
- Key results
  - Scala vestibuli
  - Scala tympani
  - Basilar membrane
  - Resolution of roughly 10 micrometers

Courtesy Dorland’s Medical Dictionary

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Experimental Results (continued)

Courtesy Lin et al
Experimental Results (continued)

Courtesy Lin et al
Assessment

• Relevance of results to project
  • Similar side-viewing OCT probe setup
  • Possibility of contour not addressed
  • Key structures identified
  • Signal strong enough to see into adjacent cavities
  • Informative about cochlear structure
  • Lacked detail concerning precision

• Future Work
  • Identifying endolymphatic hydrops
  • Intratympanic injections
  • Various other otologic procedures
Bibliography


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[Logos of ERC and CISST]
Questions?