Introduction

- Cochlear implant surgery is a very delicate operation, and has the risk of damage to sensitive tissue if the electrode is not properly inserted.
- Goal is to develop a safe path for electrode insertion using micro borescope and steady hand robot.

The Problem

- In the current practice of cochlear implant surgery, the insertion of the electrode into the cochlear is typically performed manually without intraoperative imaging.
- Manual insertion of electrode can generates forces that are large enough to damage the sensitive tissue of the cochlea. This damage can further reduce the residual hearing of the patient.
- It is difficult to properly register pre-operative imaging data with a tool while it is inside the cochlea.

The Solution

- Micro borescope (0.5mm diameter) enables intraoperative imaging within the 1mm diameter cochlear canal.
- Steady hand robot provides positioning precision of 1µm.
- Steady-hand robot adapter mount which allows for easy switching between imaging and implant tools makes registration simpler and more accurate.
- Safe insertion path can be generated by analyzing image data from borescope.

Outcomes and Results

- Adapter with interchangeable tips for imaging probe and electrode
- Manual safe path finding
- Robot position recording
- Safe path generation
- Real-time segmentation
- Borescope calibration

Future Work

- 3D reconstruction of cochlear canal
- Automatic safe path and virtual fixture generation
- Precise robot movement through inverse kinematics

Lessons Learned

- Always have a backup logistics plan
- Cross platform coding requires lots of troubleshooting

Credits

- Alperen Degirmenci: adapter design and prototyping, optical flow, borescope calibration
- Saumya Gurbani: segmentation, safe path GUI, EyeRobot interfacing, safe path recording
- Xingchi He: adapter design and prototyping, safe path generation, borescope calibration

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