Designing Force Sensing Forceps for Cochlear Implant Surgery

Computer Integrated Surgery II
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Introduction

- During a cochlear implant surgery, an electrode is inserted into the cochlea
- The location and orientation of the electrode is crucial for a successful implant operation and preservation of residual hearing
- The cochlea is very fragile and is prone to trauma at force outside the scope of surgeon's tactile resolution
- The rate of traumatic surgery is 17.6% (Hoskison, 2017)

The Problem

- Currently there are no established methods to help with atraumatic electrode insertion.
- Studies measured force threshold for a traumatic surgery, but measurements are done to cadavers and cochlea models which does not mimic surgical environment.

The Solution

- Create a hand-held force-measuring forceps that can be used intraoperatively.

- This way, we can 1) measure insertion forces during surgery and 2) provide feedback to the surgeon when a certain force threshold is breached, preventing trauma.
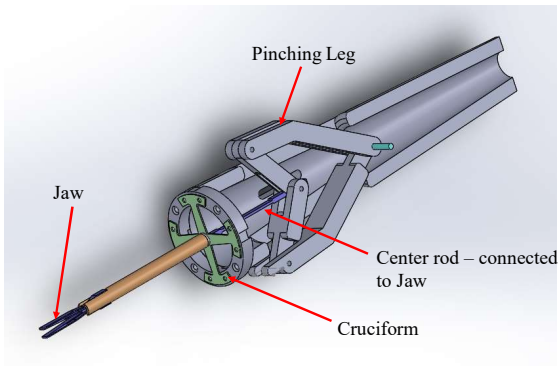

Figure 1. Force-sensing forceps CAD design

- Pinching the pinching leg closes the jaw

- Force applied to the jaw (from electrode insertion) is translated to a measurable deformation of the cruciform.

- Strain gauges placed at the cruciform measures this deformation, which can be computed back to the insertion force at the jaw
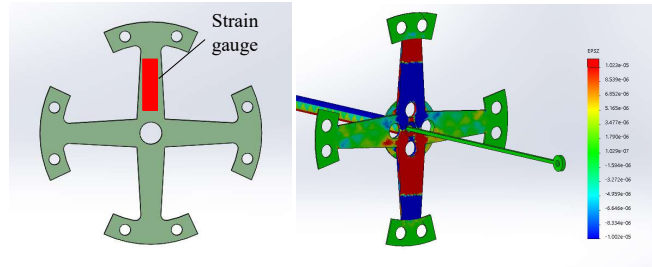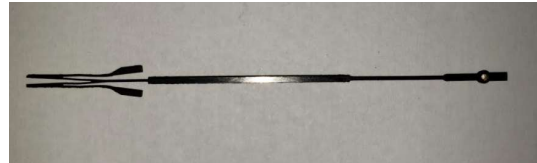

Figure 2. Cruciform design (left) and Deformation simulation (FEA) of the cruciform (right)

Outcomes and Results

- Simulation of the actuation is complete
- Simulation of strain at the force-sensing component of the forceps is complete
- Currently, the forceps is about half-way finished with the prototyping process.

Future Work

- I will be continuing this work through 2021 summer-2022 summer
- Once the prototype is ready, calibration will be performed
- Tests will be performed on a cochlea model with Dr. Galaiya

Lessons Learned

- Need to investigate and document design requirements thoroughly in the earlier stage

- Manufacturing requirements of different methods (laser cut, 3D print, EDM) including material selection

Credits

- Justin Kim – sole member responsible for everything

Publications

- NDA & Plans to submit a patent

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- Dr. Deepa Galaiya – Surgeon mentor

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