Computer Integrated Surgery II

Force-Sensing Forceps for Cochlear Implant Surgery

Ajay Gawade

Mentors:

Dr. Deepa Galaiya, Prof. Russell Taylor, Anna Goodridge, and Justin Kim

Introduction

The project's goal is to design a prototype for testing the force-sensing forceps that can measure perception force by the surgeon, thereby enabling successful and safe insertion procedures that will eventually reduce the trauma rates. We focussed on:

- Designing and developing a fully working prototype.
- Calibration and testing of the new Force/Torque sensor.
- Experimental methods to create calibration procedures to validate the sensor data concerning ground truth.

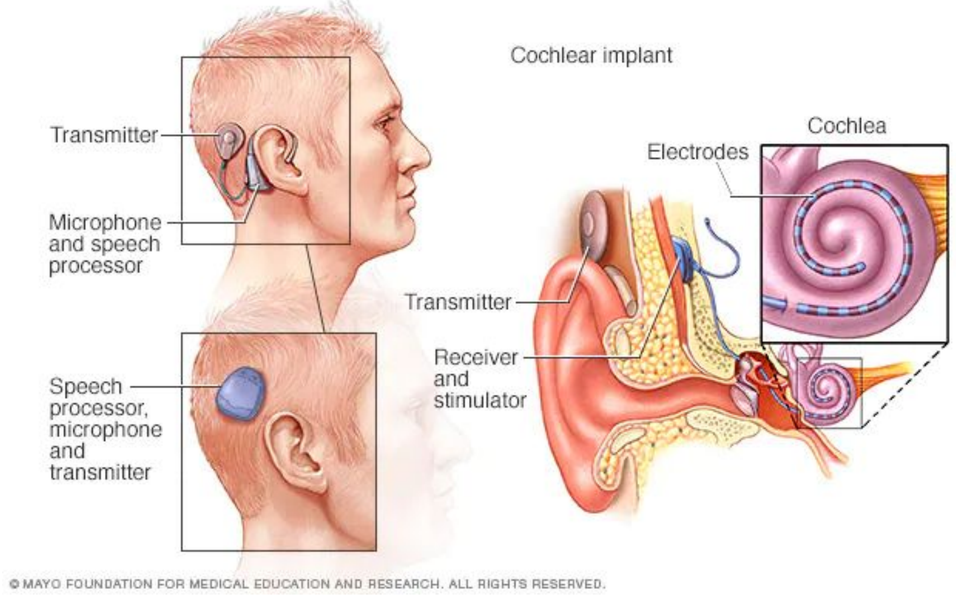

Fig: Cochlear Implant with inserted electrode array

The Problem

- Studies show that an overall **17.6%** trauma rate implies that CI (Cochlear Implantation) insertion could be improved with more accurate and consistent electrode insertion using suggested techniques and types of electrodes.
- The Force sensing forceps will control the <u>minimal force</u> required in the cochlear invasive implant surgeries, preventing the surgeons from damaging the cochlea, etc. The design will also make the cochlear implant process easier by "*Gripping electrode.*"

The Solution

- The aim is to limit the force within <u>18mN</u> to reduce the damage caused by the CI.
- The forceps are attached to a Force sensor, <u>WITTENSTEIN™ Hex21 6 DoF Force Sensor</u>, which collects data in real-time.
- Generated data is validated through mathematical equations, FEA analysis and physical measurement.
- The resultant force is the same perception force by the surgeon during CI procedure to limit in threshold.

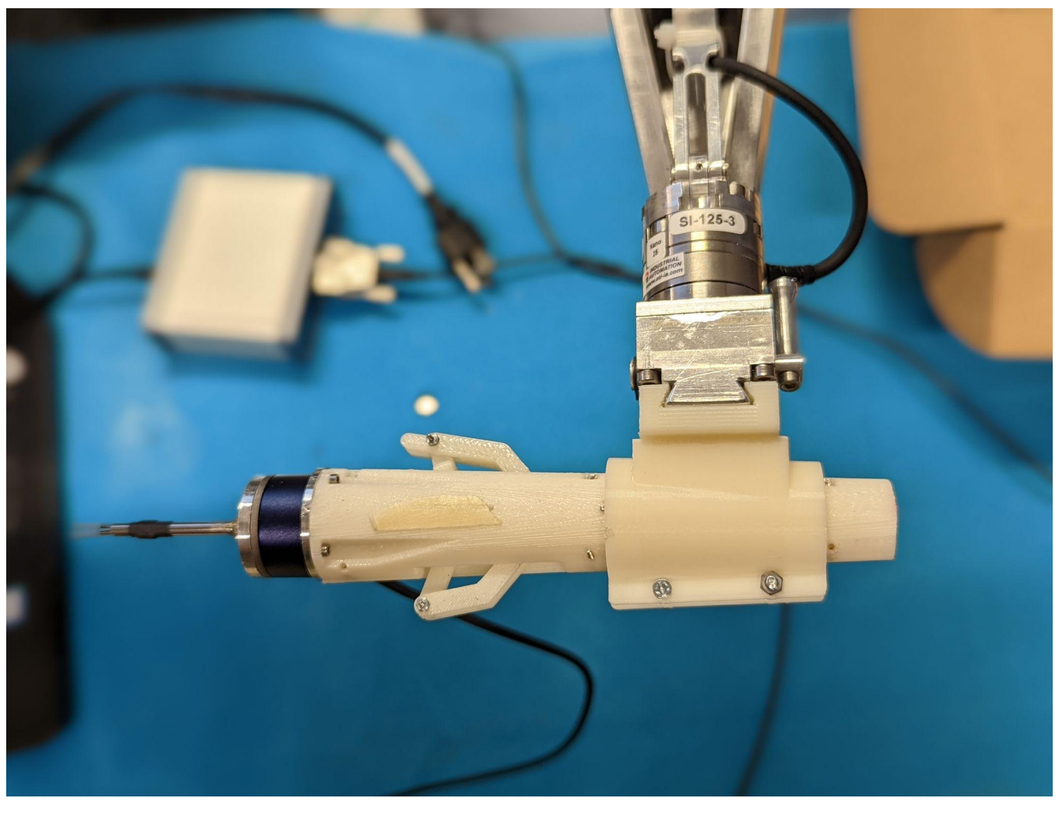

Fig: Developed prototype of the Force Sensing Forceps

Fig: Actual Electrode Insertion Setup

Outcomes and Results.

- Once the sensor data is validated, it can be compared to the Nano-43 ati sensor.
- The *normally closed design will give better results as the CI procedure eliminates the pinching force because of no pinching action.
- Maximum Insertion force reduce to **28mN** using experimental setup and procedure.

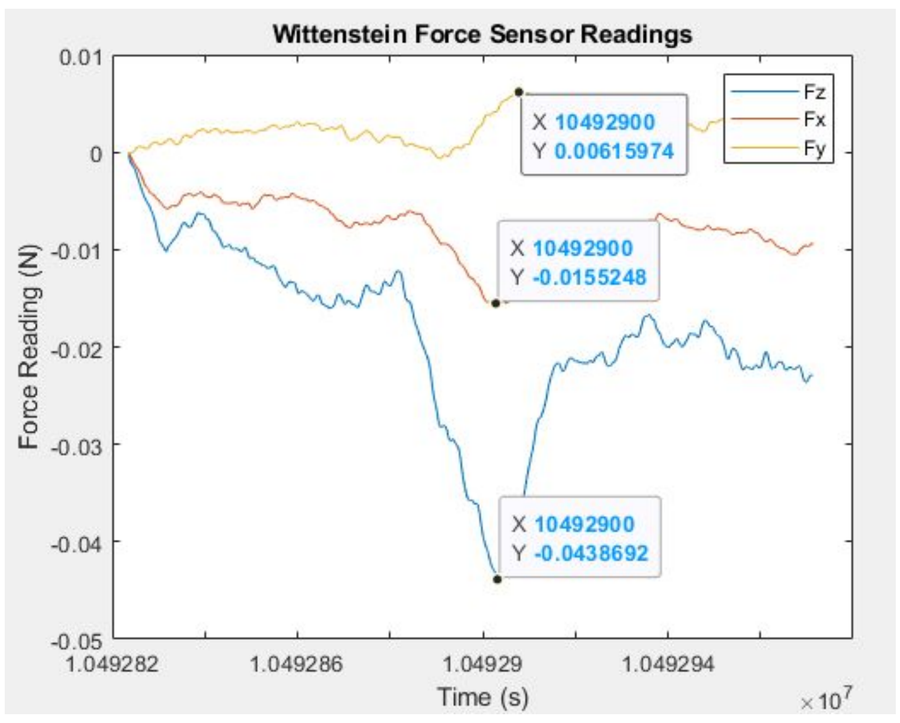

Fig: Force in Fx, Fy and Fz direction

Future Work

- After a better calibration method and experimental procedures, the HEX 21 sensor can be used for calculating the perception forces by the surgeon once it is attached to the forceps.
- Bayesian Interpolation to be used to map the actual vs. expected output as well as Bernstein Polynomial to calibrate the measured data.
- The end goal is to develop “Robot Assisted Cochlear Implant Surgery”

Lessons Learned

- Improving work processes, operation, quality, safety of medical devices in the laboratory.

Publications

- Hoskison E, Mitchell S, Coulson C. *Systematic review: Radiological and histological evidence of cochlear implant insertion trauma in adult patients*
- Kratchman, Louis B., Daniel Schuster, Mary S. Dietrich, and Robert F. Labadie. "*Force perception thresholds in cochlear implantation surgery”*.

Support by and Acknowledgements

- Laboratory of Computational Sensing and Robotics, Johns Hopkins Medicine Institute