



Force-Sensing Forceps for Cochlear Implant Surgery and Hand Control Interface for Galen Tool Holder

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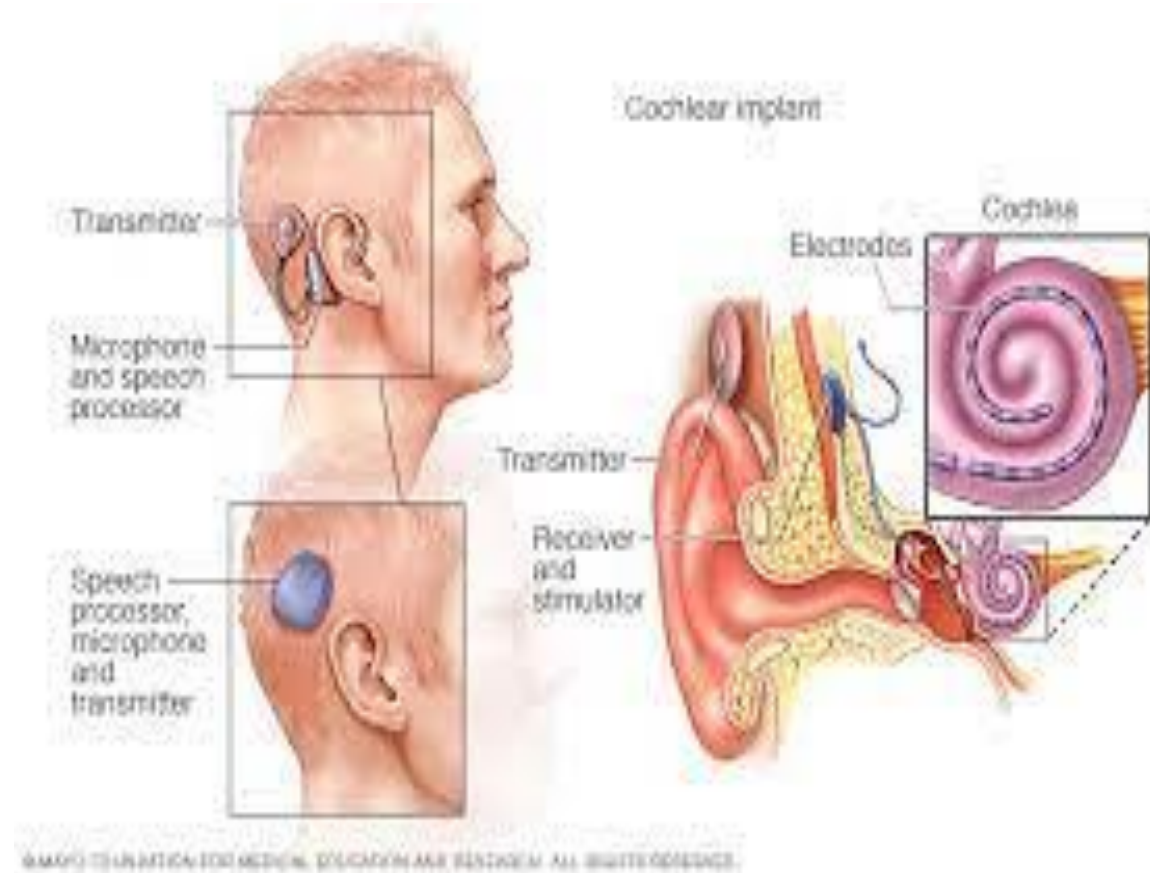
JOHNS HOPKINS
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Background of the Project

- A cochlear implant is a small electronic device that electrically stimulates the cochlear nerve (nerve for hearing).
- As of December 2019, approximately **736,900** registered devices have been implanted worldwide [1]
- Studies show that overall, **17.6%** trauma rate which implies that CI (Cochlear Implantation) insertion could be improved with more accurate and consistent electrode insertion [2]



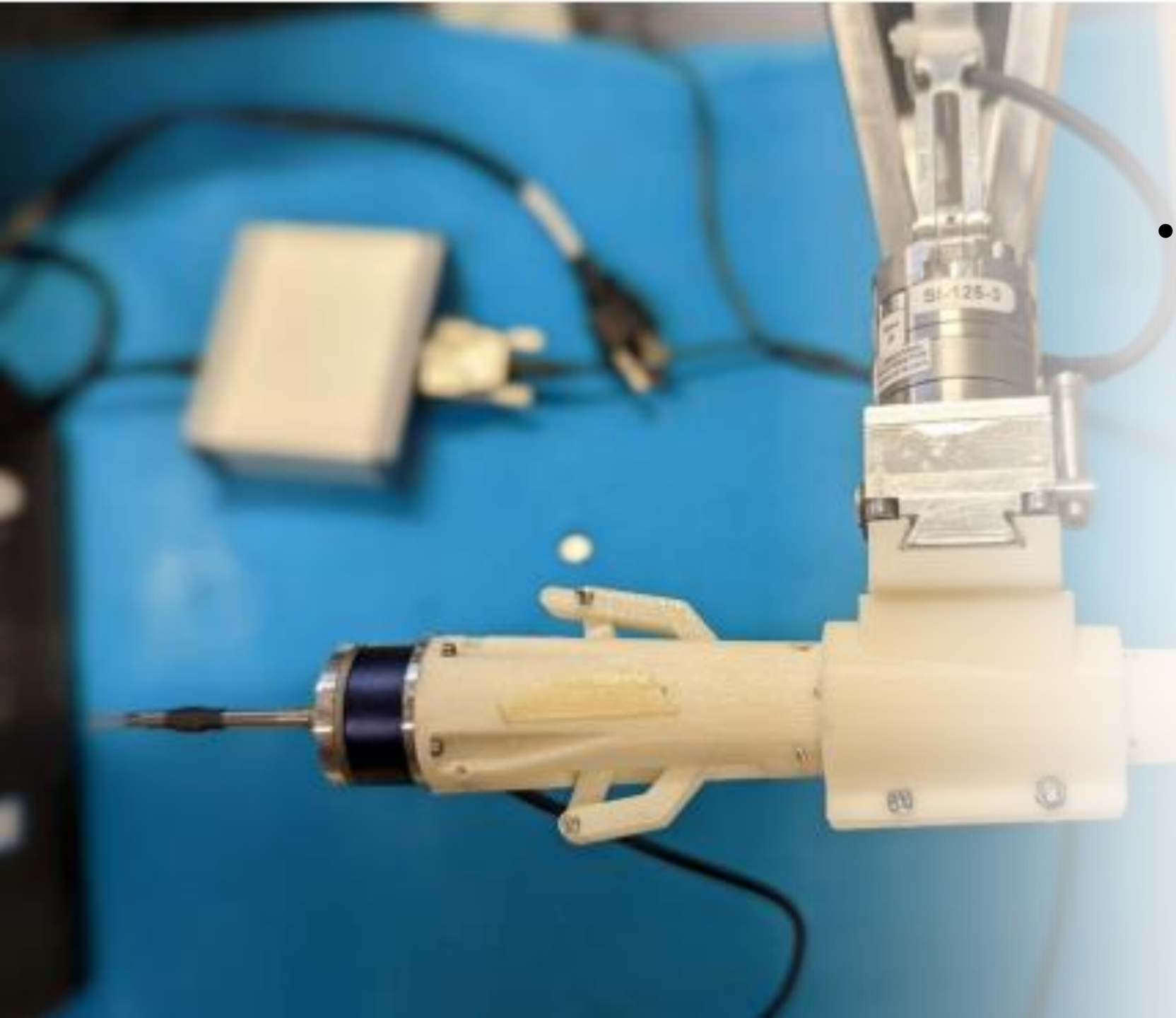
Background of the Project

- Surgeons use 'Foot Pedal' to operate the Galen Robot to change the 'Gains'
- Surgical tools/instruments are attached to the Galen
- Interfacing "Switches" with the tool mounting by taking ergonomic feedback from the surgeon.



Goals

- To design and develop a fully working prototype and testing
- Calibration and Testing of the new Force/Torque sensor
- Experimental methods to create calibration procedures to validate the sensor data concerning ground truth.
- To design the grip and placement of the buttons (switches) based on ergonomic feedback from the surgeon.
- To interface the buttons with the controller externally to change the gain of the controller.



Relevance

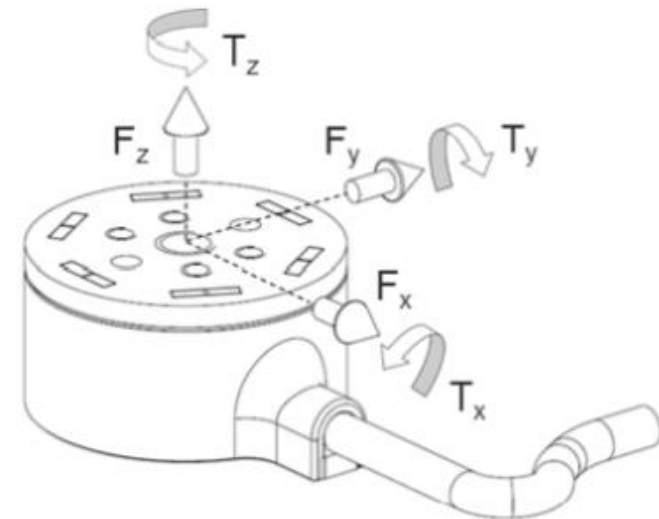
- The Force sensing forceps will control the minimal force required in the cochlear invasive implant surgeries which will prevent damage by the surgeons. The design will also make the cochlear implant process easier by **“Pinching electrode”**.

Technical Approach



1. Force Sensing Forceps:

- Force/Torque sensor “ WITTENSTEIN™ Hex21 6-Axis Force/Torque Sensor
- Validating data through experimental methods by calculating spring constants and Jaws
- Developing calibrating procedure to compare the ground truth





Technical Approach



2. Galen Hand control:

- Design a sleeve to attach 'Switches'
- Interface the external DAQ hardware to the Galen controller
- Establishing communication with the external hardware
- Use preset gain to operate Galen



Dependencies

Dependency	Associate contact	Action Plan	Contingency
Functioning of sensor	Sabastian, Anna	Replacement	Different sensor setup
Calibration of sensor	Deepa, Anna	Design calibration procedure	Less accurate results
Desing challenges	Justin	Optimum design	Less accurate results
Code repository, ROS packages	Florin	Establish comm. with DAQ hardware	Using different DAQ else project will not proceed
Galen Availability	Anna	Calender bookings	Robotorium B08H

Deliverables

	Deliverables	Dates
Minimum	Improved design of the Forceps	1-March
Minimum	Complete Integration of Prototype	8-March
Minimum	Interface of the DAQ with controller	15-March
Expected	Sensor data collection and validation	29-March
Expected	Calculating actual forces using the Jaw and the spring load	12-April
Expected	Validation of the ground truth data	26-April
Expected	Calibration of the sensor and jig	3-May
Maximum	More tests under different conditions	TBD
Maximum	Variables gain of the controller in real-time	TBD
Maximum	Report of calibration data and analysis	TBD

Management Plan

- **Weekly general LCSR lab meetings (on Wednesday at 10 am):** Here, I will report weekly progress regarding the Galen updates.
- **Weekly meetings with Anna Goodridge and Dr. Deepa (on Wednesday at 3 pm at MOCK OR):** I will find out how to best progress based on the feedback received from the general lab meeting and consult with Anna.
- **Meetings with Justin by schedule:** If needed, I will schedule separate meetings with Justin for his consult at least once a week and in-person discussion too.
- **Meetings with Dr. Deepa Galaiya by schedule:** If needed, I will schedule separate meetings with Dr. Galaiya for her consult, and to schedule calibration and testing.

Reading List

- Gao, Anzhu, et al. “3-DOF Force-Sensing Micro-Forceps for Robot-Assisted Membrane Peeling: Intrinsic Actuation Force Modeling.” 2016 6th IEEE International Conference on Biomedical Robotics and Biomechatronics (BioRob), 2016, doi:10.1109/biorob.2016.7523674.
- Handa, James, et al. “Design of 3-DOF Force Sensing Micro-Forceps for Robot Assisted Vitreoretinal Surgery.” IEEE Engineering in Medicine and Biology Society, 2013, doi:10.1109/EMBC.2013.6610841
- Hong, Man Bok, and Yung-Ho Jo. “Design and Evaluation of 2-DOF Compliant Forceps With Force-Sensing Capability for Minimally Invasive Robot Surgery.” IEEE Transactions on Robotics, vol. 28, no. 4, 2012, pp. 932–941., doi:10.1109/tro.2012.2194889.
- <http://wiki.ros.org/Topics>
- ROS: an open-source Robot Operating System Morgan Quigley* , Brian Gerkey† , Ken Conley† , Josh Faust† , Tully Foote† , Jeremy Leibs‡ , Eric Berger† , Rob Wheeler† , Andrew Ng* *Computer Science Department, Stanford University, Stanford, CA
- K. Zareinia *et al.*, "A Force-Sensing Bipolar Forceps to Quantify Tool–Tissue Interaction Forces in Microsurgery," in *IEEE/ASME Transactions on Mechatronics*, vol. 21, no. 5, pp. 2365-2377, Oct. 2016, doi: 10.1109/TMECH.2016.2563384.

References

- <https://www.nidcd.nih.gov/health/cochlear-implants>
- Hoskison E, Mitchell S, Coulson C. Systematic review: Radiological and histological evidence of cochlear implant insertion trauma in adult patients. Cochlear Implants Int. 2017 Jul;18(4):192-197. DOI: 10.1080/14670100.2017.1330735. Epub 2017 May 23. PMID: 28534710
- <https://www.wittenstein.de/fileadmin/Meta-Visuals/Microsites/resense/flyer/flyer-resense-hex-21.pdf>
- <https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/cochlear-implant-surgery#:~:text=A%20cochlear%20implant%20is%20a,internal%20part%20of%20the%20implant.>



Questions