Robot-Assisted Transcranial Magnetic Stimulation for Subjective Visual Vertical Assessment

Computer Integrated Surgery II
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Introduction
• We implemented the systematic application of transcranial magnetic stimulation (TMS) over a grid area on the brain cortex
• We also created software to move along linear unobstructed paths in a grid-like fashion with simple force feedback
• A custom tool was designed and built to hold the TMS coil parallel to end effector

The Problem
• The subjective visual vertical (SVV) has been linked to the activity of the supramarginal gyrus
• TMS is used to inhibit brain activity during the assessment of the SVV
• Manual application of TMS can be imprecise and forces researchers to take their focus away from experiments.
• There is also a need to visualize results of TMS application easily to identify key regions of the brain associated with certain activities

The Solution
• Our solution was to control location of TMS application by allowing a UR5 robot to hold the coil adjacent to the subject’s head
• The robot was given a force sensor and strict safety limits to prevent excessive force against the head
• We created a custom tool that would hold the coil parallel to the end effector of the UR5, integrated with the force sensor
• We made an algorithm to find the optimal path to traverse a grid of points without exceeding force limits at any point

Outcomes and Results
• The robot environment was set up in Slicer simulation with sample models of subject heads and approximate model of TMS coil
• Our robot was successfully able to position the end effector at specified locations and travel between them in a linear fashion
• Force feedback was implemented at a basic level (spring), but required more experimental data to be complete
• The tool was designed in SolidWorks and 3D-printed before being assembled and attached to the UR5

Future Work
• Work will be continued over the course of the next year and measurements from the force sensor could potentially be taken as soon as next week.
• We plan on interfacing with Brainsight for visualization of brain activity
• At the end, every step of the TMS application and SVV assessment should be possible from the same workstation without having to get up

Lessons Learned
• Experience with SolidWorks and Slicer
• Keeping tool orientation constant is somewhat tricky when the tool tip is angled in an odd way relative to the end effector.
• Construction of the tool holder should be started early to prevent inability to measure force constants
• Practical application of knowledge from class regarding constraints and frame transformations

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