Multi-electrode current optimization for targeted and directional tDCS in a realistic head model

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Introduction

Transcranial direct current stimulation (tDCS) stimulates the brain by injecting low amplitude currents through the electrodes on the scalp.

- Targeting a specific region and Polarity of the stimulation are important depending on the clinical purpose.
- Using smaller electrodes instead of patch electrodes might increase the focality.
- Manual optimization is very hard, the parameter space is huge.

Goal: Maximize the directional current density in region of interest without violating safety constraints.

Stimulation of different ROIs in Anterior and Superior Directions

ROI is directionally stimulated
- Desired direction has a critical effect
- Isolated source and sinks!!!

Head Model and FEM

Stimulating different ROIs in Anterior and Superior Directions

ROI may be stimulated in the desired direction
- Add current density constraints to prevent hotspots and skin burns
  - Number of constraints increases considerably
  - Might be computationally heavy
  - Problem specific optimization solver may be needed
- Include anisotropy for more accurate simulations

Original Problem

Equivalent Convex Problem

• a and b in convex problem are calculated using Forward Matrix and Linear FE Mesh.

Radial and Tangential Stimulation of same ROI

References:

1 Biomesh3D: Quality Mesh Generator for Biomedical Applications. Scientific Computing and Imaging Institute (SCI) http://www.biomesh3d.org

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