Automatic extraction of subdural electrodes for epilepsy surgery

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Overview

• Introduction to epilepsy surgery
• Important of post-op MRI images
• Artifacts and Constraints
• Filtering and analysis of MRI images in search of algorithm to automatically detect and extract subdural electrodes
• Future work

Medical Background

• Epilepsy is a condition in which person has recurrent seizures
  – Seizure – abnormal, disorderly discharging of the brain’s nerve cells, resulting in a temporary disturbance of motor, sensory, or mental function
  – Cause: tumor, chemical imbalance, head injuries, certain toxic chemicals or drugs of abuse, stroke (hemorrhage), birth injuries

Medical Background (con’t)

• 1% of US population affected
• Cure:
  – Medications
  – Brain surgery
• Epilepsy surgery is one of the safest types of brain surgery
  – Doctors need to know what part of a brain to remove
    • Make sure that it is a gray matter not a functional

Post-op MRI images

• Post-op MRI images taking after electrodes have been implanted
• 3 weeks to monitor brain activity and identify abnormal areas
• Map electrodes with abnormal readings to the patients brain*
• Check function of abnormal areas with functional MRI

Observations of MRI images
Observations of MRI images

Algorithm:
1. Has to be inside dark sphere (Rmin)
2. Skin segmentation inside brain (threshold)
3. Min distance between two centers (Dmin)
4. Certain number of electrodes (N_el)
5. Slope gradient
6. Smart search

Slope Gradient computation

Net Slope Gradient with 4 constraints

Example, original image

Example, dI/dx and dI/dy

Example, computed gradient and slope gradient
Future Work

• Improve slope gradient
• Perform search in 3-D
• Develop smart search based on size and geometry of the electrode grid
• Validation against CT/MRI and manual

Questions??