Imaging Source Distribution from Electromagnetic Signals

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Inverse Imaging Strategy for Estimating Extended Sources from EEG and MEG

Iteratively reweighted edge sparsity minimization (IRES) is an inverse imaging strategy for estimating extended sources from electroencephalography (EEG) and magnetoencephalography (MEG). IRES can quantitatively and objectively image the extent of electrical sources in an organ system from noninvasive electromagnetic signals measured over the body surface. Source sparsity is exploited in multiple domains (e.g., mathematical domains, like spatial gradient) using an iterative method and does not require thresholding to obtain extended-source solutions. The iterative reweighting algorithm penalizes locations less likely to contain any source, estimating source extent within reasonable error bounds and providing reasonable information regarding location and extent of underlying sources. The technology, evaluated in mapping brain source extent, may estimate source extent in epilepsy patients and could also apply to other organ systems (i.e., mapping source extent of cardiac arrhythmias or electrical activity from other organ systems).

Estimates Source Extent Without Ad hoc Thresholding

Estimating extended brain sources using EEG/MEG source imaging techniques is challenging. While EEG and MEG have excellent temporal resolution on the millisecond scale, their spatial resolution is limited due to volume conduction effect. Competing techniques cannot estimate source extent without using ad hoc thresholding. This unique approach estimates extended sources without requiring subjectively thresholding the solution. Computer simulations evaluated IRES by varying different parameters (e.g., signal-to-noise ratio (SNR) and source location) and comparing the estimated results to targets using metrics such as localization error (LE), area under curve (AUC) and overlap between estimated and simulated sources. IRES provided extended solutions which not only localized the source but also provided estimation for the source extent. IRES was further tested in epileptic patients undergoing intracranial EEG (iEEG) recording for pre-surgical evaluation, and the results demonstrated good concordance between noninvasive IRES source estimation with iEEG and surgical resection outcomes.

BENEFITS AND FEATURES:

- Estimates extended sources from EEG and MEG
- Does not require thresholding
- Provides extended solutions
- Localizes source and provides estimation for source extent
- May apply to other organ systems

APPLICATIONS:

- Noninvasive brain mapping
- Imaging brain activations
- Surgical planning in epilepsy patients
- Treating various brain disorders to guide diagnosis and disease management
- May apply to other organ systems (e.g., mapping source extent of cardiac arrhythmias)

Phase of Development - Pilot scale demonstration

Researchers

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Publications

Imaging brain source extent from EEG/MEG by means of an iteratively reweighted edge sparsity minimization (IRES) strategy
NeuroImage, Vol 142; Nov 15, 2016; ppg 27-42

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