A Novel and Powerful Method for Signal Processing in Medical Imaging (MEG, MRI, etc.) and Other Scientific and Engineering Applications

Tech ID: 21448 / UC Case 2010-340-0

BACKGROUND

Magnetoencephalography (MEG) is a functional imaging modality that directly detects neuronal activity with a millisecond temporal resolution. However, since a number of different source configurations can generate the same MEG signal, assumptions must be made about the nature of the sources (source models) to uniquely localize them. A variety of MEG source-modeling methods have been put forth, yet no single beamformer technique is capable of adequately localizing highly correlated networks from noisy MEG data without requiring both *a priori* information and expensive and impractical computation.

TECHNOLOGY DESCRIPTION

UC San Diego researchers have developed an effective and clinically practical multi-core beamformer (MCBF) method to address the various shortcomings of conventional signal reconstruction approaches including earlier dual-beamformer method, the coherent source suppression model (CSSM), and the nulling beamformer (NB).

MCBF uses a new lead-field based inverse-modeling technique to simultaneously reconstruct highly-correlated and uncorrelated sources from noisy sensor array data by incorporating the lead-field vectors of two simultaneously activated neuronal sources into a single spatial filter. With this novel beamformer, we were able to successfully compute optimal dipole weights, orientations, and pseudo-Z-scores, eliminating time-consuming searches that hindered the previous dual-beamformer approach. In addition, by utilizing a powerful Powell search with a taboo list, we were able to reconstruct optimal source dipoles quickly without the use of a priori information. The changes and optimizations made decreased the total computing time by 100 fold from tens of hours to less than 15 min, making the MCBF a clinically applicable method for MEG source localization.

APPLICATIONS

Unlike the conventional beamformer, the MCBF can handle both correlated and uncorrelated sources and thus opens a multitude of new applications for MEG to provide more sensitive diagnosis and therapeutic monitoring than conventional neuroimaging techniques (e.g., CT and MRI) for a variety of neurological and psychiatric disorders, such as: 1) traumatic brain injury (TBI), 2) stroke, 3) post-traumatic stress disorder (PTSD), 4) schizophrenia, 5) Alzheimer's dementia, and 6) autism.

Furthermore, MCBF also can be used to recover source information from any type of sensor array system, including, but not limited to, radar, sonar, astronomical telescopes, magnetotelluric sensors, and optical and other electromagnetic arrays.

ADVANTAGES

MCBF can:

- Reconstruct both correlated and uncorrelated sources.
- Be applied for both spontaneous and evoked recordings, since the method operates over a wide range of SNR.
- Automatically calculate optimal amplitude-weighting, source orientations, and correlations for reconstruction for two or more sources, reducing the computational time of the dual-beamformer technique by a factor of 100.

STATE OF DEVELOPMENT

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OTHER INFORMATION

CATEGORIZED AS

- **Computer**
  - Software
- **Imaging**
  - Medical
  - Software
- **Medical**
  - Diagnostics
  - Imaging

RELATED CASES

2010-340-0, 2010-834-0

The MCBF has been tested and validated on six human subjects during a median-nerve stimulation task for identification of multiple meaningful networks of activation without any *a priori* information.

RELATED MATERIALS

- Diwakar M, Huang MX, Srinivasan R, Harrington DL, Robb A, Angeles A, Muzzatti L, Pakdaman R, Song T, Theilmann RJ, Lee RR. Dual-Core Beamformer for Obtaining Highly Correlated Neuronal Networks in MEG. Neuroimage. 2011 Jan 1;54(1):253-63.

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	9,883,812	02/06/2018	2010-340

RELATED TECHNOLOGIES

- An Enhanced Powerful Method for Signal Processing in Medical Imaging (MEG, MRI, etc.) and Other Scientific and Engineering Applications (SD2011-252)

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