Dinh, Christoph; Haueisen, Jens; Baumgarten, Daniel; Hämäläinen, Matti S.:

Online monitoring of brain activity

URN: urn:nbn:de:gbv:ilm1-2015210096

Published OpenAccess: January 2015

Original published in:

Clinical EEG and neuroscience : official journal of the EEG and Clinical Neuroscience Society (ECNS). - London : Sage (ISSN 2169-5202). - 44 (2013) 4, S. E33-E34, FCI_3.
DOI: 10.1177/1550059413507209
URL: http://dx.doi.org/10.1177/1550059413507209
[Visited: 2014-10-14]

Abstracts of Presentations at the International Conference on Basic and Clinical Multimodal Imaging (BaCI), a Joint Conference of the International Society for Neuroimaging in Psychiatry (ISNIP), the International Society for Functional Source Imaging (ISFSI), the International Society for Bioelectromagnetism (ISBEM), the International Society for Brain Electromagnetic Topography (ISBET), and the EEG and Clinical Neuroscience Society (ECNS), in Geneva, Switzerland, September 5-8, 2013

Clin EEG Neurosci 2013 44: E1 originally published online 24 December 2013
DOI: 10.1177/1550059413507209

FC1_3. Online Monitoring of Brain Activity

C. Dinh[1,2], J. Haueisen[1,3], D. Baumgarten[1], and M.S. Hämäläinen[2]

[1]Institute of Biomedical Engineering and Informatics, Ilmenau University of Technology, Ilmenau, Germany
[2]Athinoula A. Martinos Center for Biomedical Imaging, Massachusetts General Hospital, Charlestown, MA, USA
[3]Biomagnetic Center, Department of Neurology, University Clinic Jena, Jena, Germany

Providing millisecond temporal resolution for noninvasive mapping of human brain functions, magnetoencephalography (MEG) is optimal to monitor brain activity in real time.[1] Real-time feedback allows the adaption of the experiment to the subject's reaction creating a whole set of new options and increasing time efficiency by shortening acquisition and offline analysis. Whereas data analysis to date is mostly done after the acquisition process, we introduce an approach to monitor brain activity online.

In order to handle the low signal-to-noise ratio (SNR) in single trials and at the same time cope with the high computational effort, the gain matrix is downsized. Since a low SNR reduces the number of distinguishable source localizations, regionwise clusters are calculated,[2] defined by Destrieux's brain atlas.[3] Each cortical region is represented by a cluster dipole, that is, a standard mne-toolbox source space with 7498 dipoles is reduced to a sparse source space with 176 dipoles.

The reduced number of dipoles and a preserved variance of the gain matrix improve the ability to distinguish active regions and speeds up the localization calculation at the same time. Dynamic statistical parametric mapping (dSPM)[4] is used as localization algorithm. This algorithm is able to handle Elekta Neuromag VectorView 306-channel MEG measurements and a sampling frequency of 1000 sps online with a small delay. In case the localization is applied directly to the raw data, the minimal measurement buffer for an ordinary mobile workstation of 80 samples results in an 80-ms delay. If a larger delay is acceptable, a moving average can be applied to increase the localization accuracy. The localization output is visualized in a stereoscopic real-time brain display.

First studies using both simulated and human MEG data show that the proposed real-time technique is accurate and fast. The responses to auditory and somatosensory stimuli can be

localized precisely. The stereoscopic display enables the clinician to follow the activation easily.

We conclude that online brain monitoring is a useful addition to common acquisition methods and allows acquisition of more information during the measurement. This can reduce the postprocessing effort dramatically.

References

1. Hämäläinen MS, Hari R, Ilmoniemi RJ, Knuutila J, Lounasmaa OV. Magnetoencephalography—theory, instrumentation, and applications to noninvasive studies of the working human brain. *Rev Mod Phys.*, 1993;65:413-497.
2. Dinh C, Strohmeier D, Haueisen J, Güllmar D. Brain atlas based region of interest selection for real-time source localization using K-means lead field clustering and RAP-MUSIC. *Biomed Tech (Berl)*. 2012;57(suppl 1).
3. Destrieux C, Fischl B, Dale A, Halgren E. Automatic parcellation of human cortical gyri and sulci using standard anatomical nomenclature. *Neuroimage*. 2010;53:1-15.
4. Dale, AM, Liu AK, Fischl BR, et al. Dynamic statistical parametric mapping: combining fMRI and MEG for high-resolution imaging of cortical activity. *Neuron*. 2000;26:55-67.