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**METHOD FOR LOCALIZING THE EPILEPTOGENIC FOCUS FROM  
INTERICTAL BRAIN SIGNAL PROCESSING**

(ROI 2013-06)

**Description**

- A computer implemented technique for identifying the epileptogenic focus from interictal (seizure-free, “normal”) periods in patients with focal epilepsy.
- Epilepsy is the second most common neurological disorder after stroke and affects 1-2% of the population. It is estimated that epilepsy accounts for more than \$15B annual healthcare costs and loss of income/production in US alone (CDC, 2013). Accurate localization of the region of the brain (epileptogenic focus) that precipitates epileptic seizures (the hallmarks of epilepsy) constitutes the first critical step in the diagnosis and treatment of the disorder.
- Employs measures of directed connectivity to estimate and quantify the strength of the information flow between different brain regions from interictal recordings of brain signals (e.g. electroencephalographic–EEG, magnetoencephalographic–MEG; magnetic resonance imaging–MRI; positron emission tomography–PET signals).
- Envisioned to be useful in localizing and monitoring areas of abnormal activity in other brain paroxysmal neurological disorders, apnea attacks and losses of vigilance due to sleep deprivation or awareness due to anesthesia, cardiac attacks, as well as neurodegenerative diseases, like Parkinson’s and Alzheimer’s.

**Advantages**

- Non-invasive localization of the focus. The biosignals needed to be analyzed by this method may be routinely and non-invasively procured at hospitals and/or physicians’ offices.
- Short, relatively inexpensive procedure. Currently, localization of the epileptogenic focus requires an expensive (\$2,500 per day) long (4 to 10 days) stay in a specialized well-controlled clinical environment, the epilepsy monitoring unit (EMU), and tapering of the anti-epileptic drug (AED) medication until several of the patient’s seizures occur and are recorded. Only a few epilepsy medical centers have EMU units and, because of this, there is an unmet patient demand. The developed method can localize the epileptogenic focus from as short as a 30 minute interictal recording, without the need of AED tapering and seizures occurrence.
- Safe test for patients. At EMUs, the reduction of AEDs and the need for seizure occurrence may lead to patient discomfort and, more importantly, to an uncontrollable situation, the life-threatening condition of Status Epilepticus.

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- Accurate localization of the focus. Testing the method in patients with the most difficult to detect and localize the focus type of epilepsy (neocortical epilepsy), and with inconclusive or normal MRIs, we have shown that it outperformed all clinically available methods for focus localization (Cleveland Clinic). Thus, it may soon become the gold standard for epileptogenic focus localization.
- Robust. Performs interictally, irrespectively of the absence or presence of interictal epileptiform activity in the data. Current competitive software works only when epileptiform activity (epileptic spikes, slow waves etc.) exist in the recorded data. Thus, absence of epileptiform activity in the data leads to those tests' prolongation, repetition and eventual failure.

### **Areas of Application**

- Diagnosis of epilepsy. Can be incorporated in existing and new brain monitoring machines. It can also be implemented as a standalone device/program for post-processing of the recorded data.
- Treatment of epilepsy. Especially important for accurate focus localization in resective epilepsy surgery, an effective therapy for patients with AED-resistant focal epilepsy. Has been proven superior to existing imaging techniques (MRI) and long-term EMU recordings, as it succeeded where all other methods in clinical practice failed to localize the focus in difficult cases of epilepsy patients (see publications below).
- Evaluation of epilepsy treatment. Expected to be useful in evaluating the treatment over time by identifying and monitoring the function and extent of the focus.
- Diagnosis and treatment of other brain disorders of focal origin.

### **Patent Status**

Patent pending

### **Publications**

- L.D. Iasemidis, "Seizure Prediction and its Applications", *Neurosurg. Clin. N. Am.*, vol. 22, pp. 489-506, 2011.
- Vlachos I., Krishnan B., Sirven J., Noe K., Drazkowski J., Iasemidis L. Frequency-based connectivity analysis of interictal iEEG to localize the epileptogenic focus. Proceedings of the 29th Southern Biomedical Engineering Conference 2013, Miami, FL, May 3-5 2013.
- Krishnan B., Vlachos I., Wang Z.I., Mosher J., Iasemidis L., Burgess R., Alexopoulos A.V. Advanced MEG Source Analysis for Epileptogenic Focus Localization in Patients with Non-Lesional MRI. Proceedings of the 29th Southern Biomedical Engineering Conference 2013, Miami, FL, May 3-5 2013