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Seizure onset detection and subsequent treatment through direct intra-cortical processing

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Several types of Brain-Machine Interfaces (BMI) intended for bio-signal recordings such as EEG and fMRIS, and subsequent treatment techniques such as electrical or magnetic stimulation. These wearable and portable devices, built around non-invasive devices, are in majority of cases still little efficient and bulky. Also, more the disease level is deep in a brain layer, more it is complex to be detected and consequently difficult to efficiently treat it. Neurodegenerative diseases require advanced and implantable BMIs for accurate diagnostic and subsequent treatment such local stimulation, drug delivery, or tissue cooling in order to recover complex neural vital functions. This paper covers the various steps usually needed to locate dysfunctions and to apply preferably in real time required treatment. Case study concerns epileptic foci localization and seizure detection, then treatment avoiding seizure grows and abnormal health consequence. The treatment is divided in two main steps; the first is non-invasive for coarse localisation, the second is in situ for efficient benefit. Following wearable system overview, an implantable micro device will be described which is composed of onset seizures detection based on monitoring the exponential grows of both voltage amplitude variation of Electrocorticogram (ECoG or iEEG) and its frequency content as well. Multichannel signals are recorded concurrently and custom processor is used to evaluate on real time these dual parameters (amplitude and frequency) and deliver alarm when seizure is detected. Then, a local feedback control is used to trigger a constant-current stimulator intended to stop the seizure before its emergence. Various parts of these microsystems are based on implementing custom circuits which require ultra low-power consumption and reliable wireless energy and data communication building blocks. Also, special attention is paid to face multidimensional design and implementation challenges of the implantable micro device for a mandatory safe operation.

Biography

Mohamad Sawan is a Professor of Biomedical Engineering in Polytechnique Montreal. He is a holder of Canada Research Chair in Smart Medical Devices (2001-15). He is leading the Microsystems Strategic Alliance of Quebec, and is Founder of the Polystim Neurotechnologies Laboratory. He published more than 700 peer reviewed papers, and 12 patents. He received the Queen Elizabeth II Golden Jubilee Medal, the Bombardier Medal for technology transfer, the Medal of Merit from the President of Lebanon, and the Barbara Turnbull Award for spinal-cord research in Canada. He is Fellow of the IEEE, Fellow of the Canadian Academy of Engineering, and Officer of the Quebec's National Order.

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