Workshop in Epilepsy Engineering

29-30 June 2015

Workshop Summary

The Workshop in Epilepsy Engineering was a two-day event organised by Loukianos Spyrou (Computing), Saeid Sanei (Computing), Daniel Abasolo (Biomedical Engineering) and Yue Chin (Medical Sciences). 25 participants from 5 countries participated including three keynote speakers. There were oral presentations, a panel discussion and a product demonstration from an EEG device company (OpenVivo).

Workshop Objectives

The main objective of the workshop was to bring together clinical and technical researchers in epilepsy and to encourage cross-fertilisation. Its scope was to disseminate the current methodology for epilepsy detection, encouraging the inter-disciplinary communication of algorithms, drawbacks, practical issues and performance evaluation. Members of the neuroscience, clinical research and engineering communities attended this meeting. Our primary interests were:

- Bring together epilepsy researchers from the clinical and engineering fields
- Identify the current methodology that clinicians in Epilepsy use
- Discuss new advances in epilepsy detection and treatment

Summary of Presentations

The workshop started by the keynote speech from Prof. Louis Lemieux (UCL) who discussed "Safety testing, data quality issues and implementation of combined EEG and fMRI acquisitions". Combining EEG and fMRI is a recent advancement in Epilepsy research and in the keynote speech several key points were addressed and discussed with the audience.
Next, there were three presentations by Lorena Vega Zelaya, who discussed recent work on the brain networks in temporal lobe epilepsy. Local Senior Lecturer Daniel Abasolo, presented some his results on measuring the effects of pharmacological intervention with the Lempel-Ziv complexity which can characterize the rhythmicity of signals. Yujiang Wang explained a spatiotemporal model in which focal epileptic activity evolves into a network of epileptic activity over time.

The next session started with our next keynote speaker Jonathan Halford, who presented his work on '"Standardized Database Development for EEG Spike and Seizure Detection for epileptic signals. He is currently building a framework where epileptic clinicians can mark epileptic activity through a web interface. Next, two clinical researchers from King's College London presented their work on brain stimulation and their relation to preceding epileptiform discharges and k-complexes. The day ended with two short presentations from local students demonstrating new methods of analysis of epileptic signals with non-linear time series and the central tendency measure.

The second day started with a stimulating talk by Jesus Pastor who discussed 'Distributed features in partial epilepsy: Clinical Significance of the new paradigm'. He revisited traditional assumptions about the functional areas of epileptic activity and showed that new

data concerning presurgical telemetry and intracranial EEG challenge those assumptions. Loukianos Spyrou continued with a presentation regarding algorithm development for detecting epileptic spikes on scalp EEG as compared to the gold standard of intracranial recordings. Samaneh Kouchaki presented a new method from the Surrey group regarding tensor factorisation of epileptic EEG and its advantages.

The last session started with OpenVivo company presenting new EEG recording hardware. Finally, Cristophe Bernard, our last keynote speaker ended the workshop with a exciting talk about a new method of inserting electrodes in the brain and discussed its significant advantages in signal quality and medical applicability.

Key Themes

During presentations the audience was very active by discussing the presented content. There were two main themes, technical and clinical. The technical focused on algorithm development and analysis tools on epileptic signals. And the clinical on new medical procedures, evaluation, their safety and efficacy. There were a few major areas of discussion:

- The need for safe non-invasive procedures that are easily applicable by clinicians
- Feature and detection of epileptic signals, the need for the clinical field to adapt more to advances in signal processing and machine learning was highlighted
- Network connectivity can provide insights regarding the origin and evolution of epileptic seizures
- Signal processing methods that measure specific signal properties
- Multimodal brain measurements can lead to a greater diagnostic ability of epilepsy. Especially combining EEG with fMRI
- Clinical scoring of epileptic discharges suffers from great variability between scorers. A common database accessible by all maybe a solution to that
- Electrical brain stimulation is a new and powerful tool in epilepsy treatment
- Modelling the epileptic activity is an open issue and traditional knowledge should be challenged

Future steps

We aim to repeat the workshop in the coming years due to its success. Participants will also be notified of that and be in contact regarding the discussed topics. Collaborations were initiated between Antonio Valentin and Christophe Bernard for intracranial recordings. Loukianos Spyrou with Louis Lemieux will be working on a collaboration for algorithm development for EEG-fMRI.

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