REACT: Real-Time EEG Analysis for Event Detection

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INTRODUCTION

SEIZURES are caused by a brief electrical discharge of a group of neurons in a synchronized manner. In the neonatal period, seizures are considered the most prominent feature of neurological dysfunction. In adults, ~1% of people in the world suffer from epilepsy. The total market for EEG brain monitoring approaches $1.3bn [1]. This work presents the point-of-care REACT (**R**eal-time **E**EG **A**nalysis for event Dete**CT**ion) technology for detection of neurological events in neonates and adults. REACT has been implemented in three demonstrators, namely: clinical, laboratory and ambulatory demos. The clinical demo presents the REACT technology integrated into a system for online neonatal seizure detection in maternity hospitals. The laboratory demo represents a tool for offline analysis of adult and neonatal EEG. Finally, the ambulatory demo represents a small form factor hardware implementation of the REACT technology for real-time ambulatory or unobtrusive ward monitoring.

REACT

The flowchart of the REACT technology is shown in Fig. 1. Unlike existing alternatives, the output of the system is a probability of seizure. This allows control of the final decision by choosing different confidence levels which makes it flexible for clinical needs. The REACT technology has been initially developed for neonates in [2], where it was tested on a dataset of 268 hours, and showed the state-of-the-art performance. It has been also applied to adult seizure detection [3]. The technology is patent-pending [4].

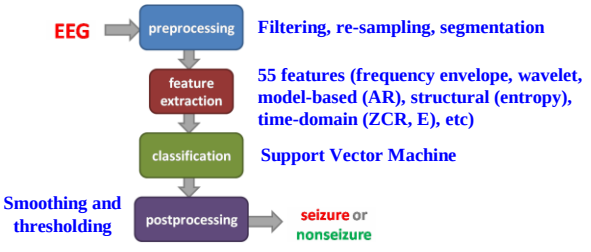

Fig. 1. Flowchart of the REACT technology

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DEMONSTRATIONS

Clinical. The REACT technology is integrated into a hospital ward-based EEG monitoring system. The online detection of seizures has been simulated with pre-recorded neonatal EEG. Appropriate indicators are integrated to alarm the clinical staff if a seizure is detected.

Laboratory. The laboratory demo shows the offline usage of the REACT technology. It has been developed with two levels of setting – for engineers and clinicians. A clinician can choose an acceptable rate of false detections per hour and see the resultant percentage of detected seizures.

Ambulatory. A prototype of the REACT system developed for use in smart ambulatory EEG monitoring is shown in Fig. 2. We use a NI-USB 9263 DAC and pre-recorded EEG data to simulate the analog voltage at a single EEG electrode. This signal is sampled at 250Hz using the AD7715, a low-power, 16-bit sigma-delta ADC. The 2048-sample EEG epoch (~8s) is then passed over a SPI interface to the REACT system implemented on a dedicated DSP processor, the Analog Devices Blackfin BF-537. If an EEG epoch is classified as seizure, the relevant data is stored in flash memory. The prototype can also communicate to a patient or doctor's computer or phone via a Lemos International LM048 mini Bluetooth adaptor.

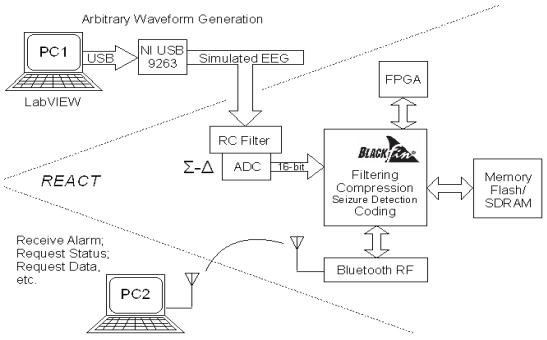

Fig. 2. REACT in the ambulatory demo

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