UNIVERSITI PUTRA MALAYSIA

DETECTION OF EPILEPTIC EEG SIGNAL USING WAVELET TRANSFORM AND ADAPTIVE NEURO-FUZZY INFERENCE SYSTEM

PEGAH KHOSROPANAH

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DETECTION OF EPILEPTIC EEG SIGNAL USING WAVELET TRANSFORM AND ADAPTIVE NEURO-FUZZY INFERENCE SYSTEM

By

PEGAH KHOSROPANAH

Thesis Submitted to the School of Graduate Studies, University Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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Dedicated to

My dearest parents and sister

whose endless love and care supported me all through the way

And, to my lovely niece, ARMITA,

whose spirit encouraged me to survive

Abstract of thesis presented to the Senate of University Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

DETECTION OF EPILEPTIC EEG SIGNAL USING WAVELET TRANSFORM AND ADAPTIVE NEURO-FUZZY INFERENCE SYSTEM

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October 2011

Chairman: Associate Professor. Abdul Rahman Ramli, PhD

Faculty: Institute of Advanced Technology

Epilepsy is a chronic brain disorder that is characterized by abrupt discharge of neurons. Epilepsy has two main classes: generalized and focal epilepsy. In focal epilepsy source of the seizure within the brain is localized but in generalized epilepsy, it is distributed.

About 1% of world populations suffer from epilepsy and one third of them have intractable seizure by medicine. Epileptics tolerate many difficulties due to seizure. Most of them also live in social seclusion. In addition, because of the medicine side effects and treatments, they may have troubles such as: double vision, fatigue, sleepiness, unsteadiness, as well as stomach upset.

An effective treatment for epileptics in some rare cases with focal epilepsy (usually in median-temporal lobe) is by operation to separate a huge part of the brain tissue which has no essential function. Consequently, most of these patients need permanent care and treatment and 25% of them have to receive high dose of drugs and laboratory treatments.

Therefore, diagnostic and warning algorithms for epilepsy infinite recognition, controlling seizure (to prepare for seizure e.g., pull over if driving) and organizing medicine schedule (to reduce unwanted side effects of not on time medication) will be useful. Such algorithms use brain electrical activity signals called electro encephalography (EEG) and have 2 methods of detection: visual (by specialist inspection) and automatic (by using signal processing knowledge).

There are some problems faced by a neurologist in the inspection of long term EEG such as; being too time consuming, analytical precision requirement, similarity of epileptic spikes with artifacts like eye blinking, and too slight epileptic spikes nature to be detected in time domain.

Proposing an automatic system to reduce time for epilepsy detection has been interesting field in recent decades.

Most epilepsy types, even in inter-ictal (between two seizure) period, have transient signs in EEG called as spike and sharp waves (SSWs) that represent epilepsy disorder and its category. Most important signs are spikes.

In this thesis an automated system has been developed to detect spikes from EEG to increase diagnosis speed, inspection precision and accuracy by applying some preprocessing such as filtering and artifact removing. Wavelet is applied as a feature extraction method and adaptive neuro-fuzzy inference system (ANFIS) is used for classification. Total accuracy of 97.5% has been obtained.

Abstrak tesis yang dikemukakan kepada Senat University Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PENGESANAN PANCANG EPILEPSI DALAM ISYARAT EEG MELALUI JELMAAN GELOMBANG KECIL DAN SISTEM INFERENS NEURO FUZZY ADAPTIF

Oleh

PEGAH KHOSROPANAH

Oktober 2011

Pengerusi: Profesor. Madya Abdul Rahman Ramli, PhD

Fakulti: Institut Teknologi Maju

Epilepsi atau penyakit sawan adalah suatu penyakit yang melibatkan gangguan otak kronik yang disebabkan oleh pengeluaran neuron secara mendadak. Epilepsi terbahagi kepada dua jenis, iaitu epilepsi umum dan eplilepsi tertumpu. Bagi epilepsi yang tertumpu, sumber serangan mendadak dalam otak adalah bersifat setempat, manakala bagi epilepsi jenis umum, ianya bersifat bertaburan.

Kira kira 1% daripada bilangan penduduk dunia menghidap penyakit epilepsi dan satu pertiga daripada mereka mengalami sawan yang sukar diurus dengan ubat-ubatan. Secara umumnya pesakit epilepsi mengalami banyak kerumitan disebabkan oleh serangan mendadak penyakit ini. Kebanyakkan daripada pesakit ini juga tinggal tersisih daripada masyarakat umum. Dalam masa yang sama, sebagai akibat kesan-kesan sampingan ubat dan rawatan-rawatannya, mereka akan mengalami masalah seperti : penglihatan berganda, keletihan, rasa mengantuk, kegoyahan serta sakit perut.

Satu kaedah rawatan bagi kes-kes terpencil pesakit yang mengalami epilepsi tertumpu (biasanya di lobus median-temporal) adalah melalui pembedahan yang mengasingkan sebahagian besar tisu otak yang tidak mempunyai fungsi yang penting. Sebagai akibat daripada ini, kebanyakan pesakit-pesakit ini memerlukan rawatan dan penjagaan secara kekal dan 25% daripada mereka terpaksa diberikan rawatan ubat dengan dos yang tinggi dan rawatan makmal.

Sehubungan dengan itu algoritma diagnostik dan amaran, pengawalan serangan mengejut (untuk mengawal serangan seperti tertarik semasa memandu) dan mengelolakan jadual perubatan berkala (untuk mengelakkan kesan-kesan sampingan yang tidak diingini berikutan jadual perubatan yang tak mengikut masa) adalah mustahak. Algoritma sedemikian rupa menggunakan petanda aktiviti isyarat elektrik daripada otak yang dikenali sebagai electro encephalography (EEG) dan mempunyai dua bentuk pengenalan: Penglihatan (oleh pemeriksaan pakar) dan atomatik (dengan menggunakan pengetahuan isyarat pemerosesan)

Terdapat beberapa masalah dihadapi oleh seseorang pakar nerologi dalam pemeriksaan jangka panjang EEG seperti: memakan masa yang agak lama, keperluan analisa terperinci, persamaan dari segi pancang epilepsi dengan artifak seperti mata terkebil-kebil dan pancang epilepsi terlalu sedikit sifat dikesan dalam domain masa.

Cadangan untuk menghasilkan satu sistem automatik bagi mengurangkan masa yang diambil untuk mengesan epilepsi menjadi satu topic yang menarik dalam bidang ini untuk beberapa dekad yang lepas.

Kebanyakan daripada jenis-jenis epilepsi, walaupun dalam tempoh inter-ictal (antara dua serangan) mempunyai tanda sementara dalam EEG yang dikenali sebagai jarum dan ombak tajam (SSWs) yang menunjukkan gangguan epilepsi dan kategorinya. Tanda-tanda yang paling ketara adalah pancangnya.

Dalam thesis ini, suatu sistem otomatik diperkenalkan untuk mengesan pancang dari EEG untuk meningkatkan kelajuan diagnosis, ketepatan pemeriksaan dan ketepatan dengan menggunakan beberapa peringkat pemprosesan seperti penapisan dan penyingkiran artifak. Gelombang digunakan sebagai kaedah penyarian dan sistem kesimpulan adaptif neuro-fuzzy (ANFIS) dipergunakan untuk pengelasan. Jumlah ketepatan sebanyak 97.5% telah diperolehi.

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I certify that an Examination Committee has met on to conduct the final examination of Pegah Khosropanah on her Master of Science thesis entitled “Detection of epileptic spikes in EEG signal via wavelet transform and ANFIS" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

PEGAH KHOSROPANAH

Date: 28 October 2011

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