DYNAMIC TOPOLOGICAL DESCRIPTION OF BRAINSTORM DURING EPILEPTIC SEIZURE

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To my beloved father and mother,
sisters and brother,
brothers in-law and nephew.

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ABSTRACT

Electroencephalograph is one of the useful and favoured instruments in diagnosing various brain disorders especially in epilepsy due to its non-invasive characteristic and ability in providing wealthy information about brain functions. At present, a large amount of quantitative methods for extracting "hidden" information which cannot be seen by "naked" eye from an electroencephalogram has been invented by scientist around the world. Among those, Flat Electroencephalography (Flat EEG) is one of the novel methods developed by Fuzzy Research Group (FRG), UTM which has been intended to localize epileptic foci of epilepsy patients. The emergence of this invention has led to the development of several Flat EEG based research (e.g., Non Polar C_{EEG} and Fuzzy Neighborhood Clustering on Flat EEG). The verification of the method has been made via comparison with some substantial clinical results. However, in this thesis, theoretical foundation of the method is justified via the construction of a dynamic mathematical transformation called topological conjugacy whereby isomorphism between dynamics of epileptic seizure and Flat EEG is established. Firstly, these two dynamic events are composed into sets of points. Then, they are forced to be strictly linearly ordered and composed into topological spaces. Subsequently, an isomorphism is constructed between corresponding mathematical structures to show that their properties are preserved and conjugate topologically. The constructed topological conjugacy is generalized into a class of dynamical systems. Within this class of dynamical system, Flat EEG's flow is shown to be structurally stable. Additionally, topological properties on the event of epileptic seizure and Flat EEG have also been established.

ABSTRAK

Elektroensifalograf adalah salah satu instrumen yang berguna dan digemari dalam mendiagnosis pelbagai masalah gangguan otak terutamanya epilepsi disebabkan oleh sifat semulajadinya yang tidak invasif dan keupayaannya dalam memberi maklumat yang banyak mengenai fungsi otak. Pada masa kini, sejumlah besar kaedah kuantitatif untuk mengekstrakan maklumat "tersembunyi" yang tidak dapat dilihat dengan mata kasar dari elektroensifalogram telah dicipta oleh saintis di seluruh dunia. Antaranya, Elektroensifalografi Rata (Flat EEG) merupakan salah satu kaedah baru yang berjaya dibangunkan oleh Kumpulan Penyelidikan Kabur (FRG), UTM atas tujuan menentukan lokasi fokus sawan pesakit epilepsi. Kemunculan ciptaan ini telah mendorong kepada beberapa pembangunan penyelidikan yang berasaskan Flat EEG (contohnya, C_{EEG} Tidak Berkutub dan Pengelompokan Kejiranan Kabur pada Flat EEG). Penentusahkan bagi kaedah ini sudah pun dibuat melalui perbandingan dengan keputusan-keputusan klinikal. Walau bagaimanapun, dalam tesis ini, teori asas bagi kaedah tersebut akan dijustifikasikan menerusi suatu pembinaan transformasi dinamik yang dipanggil topologikal konjugasi dimana isomorfisma diantara dinamik ketika serangan sawan dan Flat EEG akan dibina. Pertama sekali, dinamik ketika serangan sawan akan digubah kepada set. Kemudian, ia akan dijadikan set linear tegas dan digubah kepada ruang topologi. Seterusnya, suatu isomorfisma akan dibina diantara struktur matematik yang sepadan untuk menunjukkan sifat-sifat mereka dikekalkan dan konjugat dari segi topologi. Topologi konjugasi yang dibina tersebut juga diitlakan ke dalam suatu kelas system dinamik. Dalam kelas sistem dinamik ini, aliran Flat EEG telah ditunjukkan stabil dari segi strukturnya. Di samping itu, sifat topologi semasa serangan sawan dan Flat EEG juga dipaparkan.