ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 3, March 2017

Coherence Analysis of Epileptic Seizure and Normal EEG

Mukesh Kumar[1], Km Radha[2], Mohammad Nadeem Khan[3],

UG Student, Dept. of EIE, Galgotias College of Engineering & Technology, Greater Noida, UP, India. [1,2,3]

ABSTRACT: The second most common neurological disorder which affects the nervous system due to large number of small electric discharge of nerve cells is Epilepsy. Epilepsy affecting 0.6% to 0.8% of the world's population. Seizures are the most frequent malfunctions which occur in the human central nervous system. Electroencephalogram (EEG) is the electrical signal of the brain which contains valuable information about its normal or epileptic activity, which is used most of the time for epileptic seizure prediction. A variety of temporal charges in perception and behavior may be caused by epilepsy seizures. In the human EEG, they are depicted by multiple ictal patterns, where epileptic seizure typically becomes perceptible as characteristics usually by rhythmic signals. Detection of epilepsy is challenging because the brain's excessive discharge is different in different part of the human brain. In this paper we determine the possibilities of seizure in a person by comparing the EEG signal of that person with an EEG of epileptic patient.

KEYWORDS: Epilepsy, Epileptic seizures, prediction and detection of Epilepsy, EEG waves, Coherence

I.INTRODUCTION

Epilepsy is the world's second most common brain disorder after stroke. Nearly 3 million people are suffering from epilepsy in the US and over 50 million people worldwide (1% of the population) at present. [1]. The branch in which deals about epilepsy is termed as Epileptology. The International League Against Epilepsy (ILAE) is the worldwide professional organization which represents scientist and clinician who are working on epilepsy [2]. Epilepsy is characterized by abnormal irregular firing of neurons due to synchronous or excessive neuronal activity which takes place in the brain. Due to high complexity of brain we should apply several linear and non linear signal processing methods to analyze Electroencephalogram (EEG) signal truly. It can be managed in some patients using prescription drugs. People with epilepsy, a central nervous system disorder, suffer from recurrent seizures that occur at unpredictable times and usually without warning. Seizures can result in a lapse of attention or a whole body convulsion. If seizures occur frequent, it may increase an individual's risk of sustaining physical injuries and may even result in death. Patients with epilepsy may also suffer from a many other unwanted side effects like memory loss, depression and other psychological disorder [3]. Many people with epilepsy may not come to medical attention because of their ignorance or lack of awareness about the symptoms of epilepsy. It is particularly true of absence and minor complex partial seizures, which may only be recognized in retrospect following presentation with a generalized seizure. Indeed in one study of general practices only 20% of patients with seizures suspected the diagnosis prior to medical consultation [4]. A proper well developed device capable of quickly detecting and reacting to a seizure by delivering therapy or notifying a caregiver could ease the burden of seizures. Seizure may be defined as the phenomenon of rhythmic irregular discharge from either a specific area or the whole brain and the individual behavior generally last from seconds to minutes.

The most common way to identify the onset of a seizure before it becomes clinically manifest is through analysis of the EEG. EEG is a very important clinical tool which is used for diagnosing, monitoring and managing neurological disorder associated with epilepsy. Seizures are manifested in the EEG as paroxysmal events characterized by stereotyped repetitive waveforms that advance in amplitude and frequency before decaying ultimately. An efficient prediction about epilepsy seizure would be very useful for letting patient prepare for an imminent crisis (i.e.; move to a

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 3, March 2017

safe location). If the patient could be notified of the forthcoming seizure on time, it would be very useful for them to provide a drug to prevent the seizure from happening [5]. On a population based survey the most frequent causes of epileptic seizure are cryptogenic or idiopathic ranging from 44.5% to 67%, with the proportion of identified causes symptomatic or localization related epilepsy-remote which progressively increasing with age [6]. From the resource-poor countries it is found that more people are suffering with generalized seizures [7]. The combined use of EEG and clinical data allow us to reclassification of some cases which are clinically diagnosed as generalized seizures to partial seizures with secondary generalization, which was shown in study from Bolivia [8].

II. ELECTROENCEPHALOGRAM (EEG)

EEG is the electrical signal of brain which contains valuable information about its normal or epileptic activity. The EEG signal signifies the superposition of brain activities which are recorded as electrical potential variation at multiple spots over the scalp. EEG measures the electrical activity of brain using electrodes that are uniformly arranged on the scalp. EEG electrodes are used to measures voltage fluctuations which are resulting from ionic current flowing within the brain. The time series of such voltage fluctuations recorded by EEG is believed to correspond to neural activity, by comparing and contrasting EEG records which are obtain from multiple patients then the EEG can assists in discovering and characterizing abnormal activity in the brain [9].

It is used to differentiate between epileptic and normal seizures, via expert analysis of EEG to determine patterns corresponding to 'inter-ictal epileptiform discharge' that are prevalent in epileptic patients but rare otherwise [10]. EEG can provide information about the location of the brain which is suffering from the abnormality, and also can be used for identifying the different types of epilepsy syndromes occurring in the brain [9].The characteristics of EEG signals vary significantly among patients. In fact, EEG associated with seizure onset in one patient may closely resemble a benign pattern within the EEG of another patient. This cross patient variability in seizure and non-seizure activity causes patient non-specific classifiers to exhibit poor accuracy or ling delays in declaring the onset of a seizure [11].In most of the diagnostic and treatment-monitoring settings, the non-invasive EEG method is used in the form of scalp EEG. This form of EEG has a drawback that it is susceptible to low resolution of recording and as a result may miss out on underlying epileptic patterns. Invasive method of EEG is used when non-invasive methods give poor result in localization [12].

III. EPILEPTIC SEIZURE AND ITS TYPE

Epileptic seizures are characterized by the existence of synchronic, abnormal, sporadic and generally self-limited brain activity. Epileptic seizures are occurring because of excessive synchronized activity of large group of neurons. If a patient sustains responsiveness during a partial seizure he/she is diagnosed with simple partial seizures. If non-responsive, the event is classified as a complex partial seizure. A simple partial seizure may develop into a complex partial and/or secondary generalized seizure if the proper treatment is not done. In generalized seizure does not have a regular onset, and an immediate loss of awareness is detected. In generalized seizures both hemispheres affect simultaneously without a focal onset.
Various types of seizures are [1]

a) Absence seizures
b) Myoclonic seizures
c) Tonic seizures
d) Clonic seizures
e) Atonic seizures
f) Tonic clonic seizures.

IV.DATA USED

The data used in this paper was made available by the Bonn University for research purposes only and is described in Andrzejak et al. [13]. The complete data set consists of five sets (from A to E) each containing 100 channels.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 3, March 2017

Sets A and B consists of EEG segments taken from surface EEG recordings carried out on five healthy volunteers. The recording was carried out using a standardized 10-20 electrode placement scheme. Volunteers were relaxed in an awaken state with eyes open (Set A) and eyes closed (Set B) respectively. Set C, D, and E were taken from EEG archive of pre-surgical diagnosis. Segments in set D were recorded from within the epileptogenic zone, and those in set C from the hippocampal formation of the opposite hemisphere of the brain. Set C and D contains only activity measured during seizure free intervals and set E contains only seizure activity [14]. All EEG signals were recorded with the same 128-channel amplifier system, which are digitized with a sampling rate of 173.61 Hz and 12 bit A/D resolution. The obtained data was filtered to get the desired band using a band pass filter having a pass band of 0.53-40 Hz (12dB/octave) [15].
In this study, first two channel of each dataset of A-D is used and we determined the coherence with the first two channel of dataset E. These datasets have been also used and studied by other researchers.

a) Set A from Z000.txt - Z100.txt
b) Set B from O000.txt - O100.txt
c) Set C from N000.txt - N100.txt
d) Set D from F000.txt - N100.txt
e) Set E from S000.txt - S100.txt

V.RESULT

Coherence is defined as the examination of two signals or data set and the coherence spectrum is defined as the modulus of the normalized cross-spectrum

$$C_{xy} = \left| \frac{|Sxy(f)|}{\sqrt{(Sxx(f)Syy(f)}} \right.$$

Where S_{xx} and S_{yy} are taken from the diagonal of the matrix S(f) and represent the power spectral density of the two EEG signals (x(t) and y(t)) under study [16].

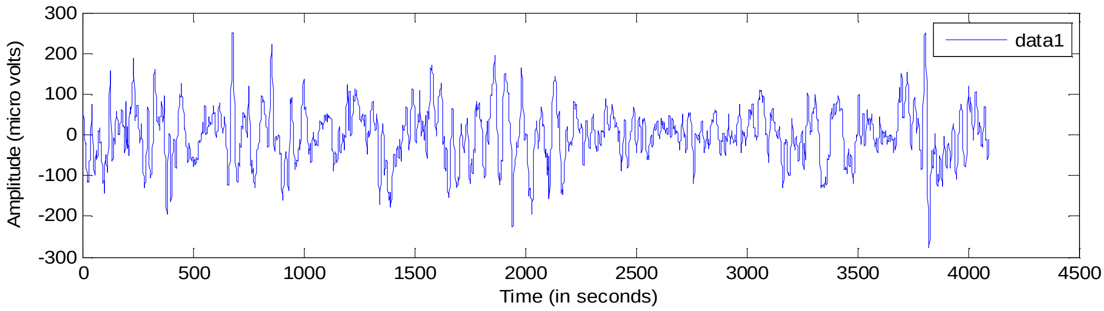

Fig 1. EEG signal of a Normal Healthy Volunteer

We observe that the electrical signal generated by the brain in normal condition range is -300 to +300 micro volts which can be easily tolerated by the human body but in case of excessive electric discharge takes place in the brain as we see in the fig 2 that its range is from -2000 to +2000 micro volts. Human body can not tolerate such a huge electric discharge so it appears in the form of seizures.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 3, March 2017

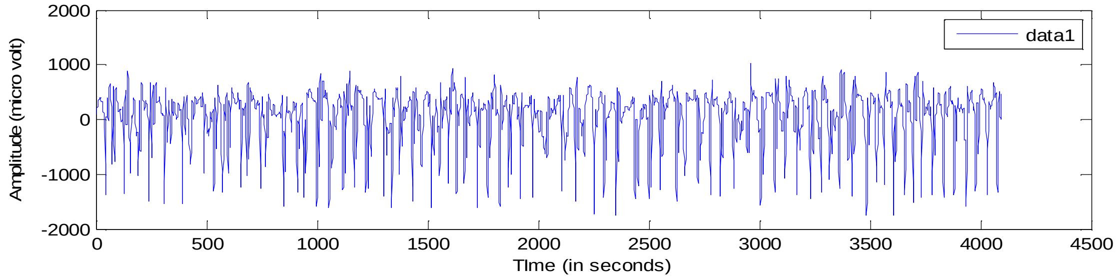

Fig 2. EEG signal of a Epileptic Volunteer

Now we determine the coherence of both normal and epileptic volunteers. The coherence value lies between from 0 to 1. We determined the coherence of first two channel of each dataset (A-D) with the first two channel of dataset E correspondingly and create dataset.

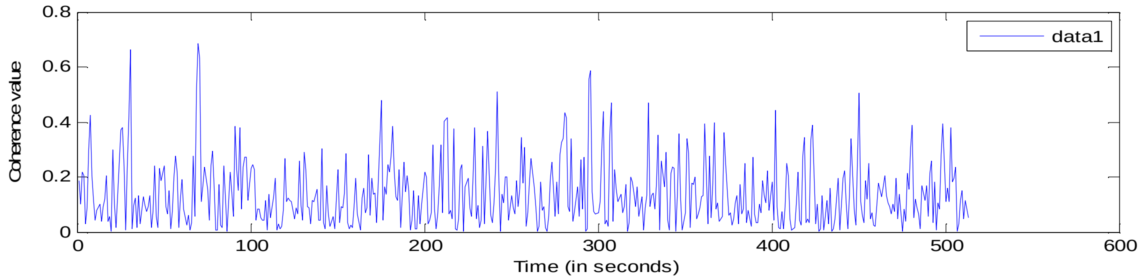

Fig 3. Coherence of Fig1 and Fig2.

We plot the histogram of each dataset that we have created for the analysis of in which volunteers the chance of seizure is maximum. In the fig 4 we observe that from the cohernce range 0.7 to 0.9, the number of coherence value is negligible and from coherence range 0 to 0.1, the number of coherence value is maximum. In the fig 5 we observe that between the coherence range of 0.8 to 0.9, the number of coherence value is negligible whereas from coherence range 0 to 0.1, the number of coherence value is maximum.

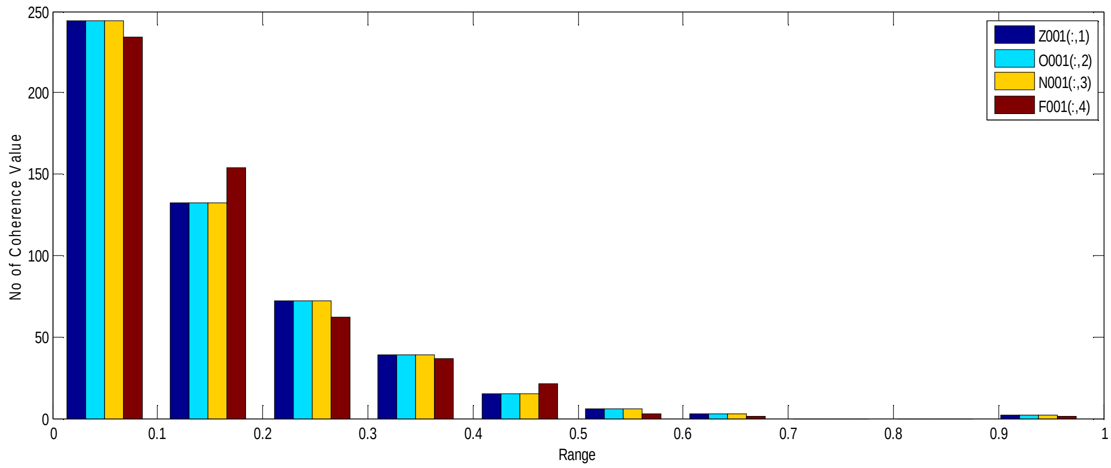

Fig 4. Histogram of first channel of Set E with corresponding channel of set (A –D).

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 3, March 2017

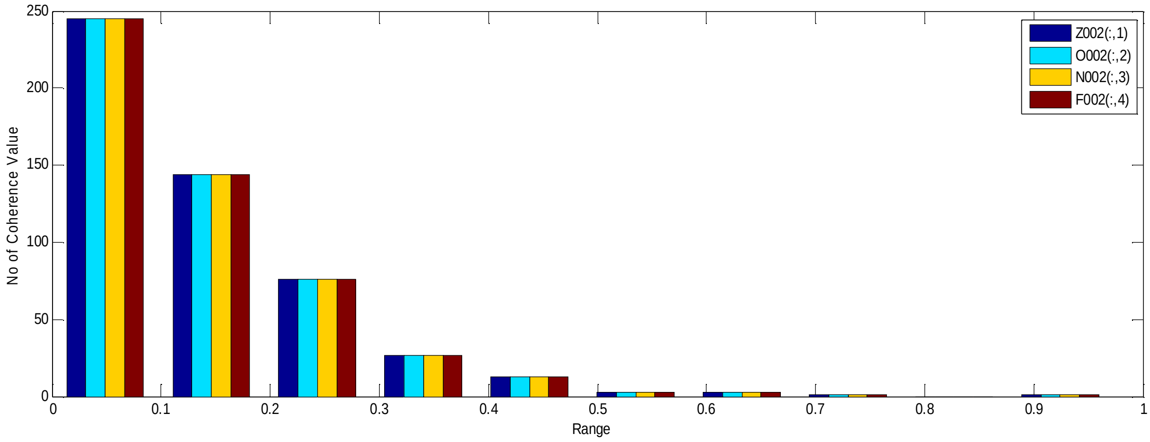

Fig 5. Histogram of second channel of Set E with corresponding channel of set (A –D).

VI. CONCLUSION

On the basis of above result we conclude that the maximum possibility of number of coherence value lies between the coherence range of 0 to 0.1 which means the possibilities of epilepsy is more in that region and nigligible number of coherence value lies between the coherence range 0.8 to 0.9 mean there is no possibily of epilepsy in that region. We also conclude that F000 (Set D) has the maximum fluctuation than the other datasets. If the coherence data of a normal healthy person is similar or identical to the coherence data of an epileptic patient then there is maixum possibility of occuring seizure in that person which can help in identifying the sizure attack. If we predict about the seizure on time then we may provide proper medication and care to them and cure them before occuring seizure.

REFERENCES

[1]. N.Sivasankari, Dr. K. Thanushkodi, Prof. H.K.Naidu, "An Extensive Review of Significant Researches on Epileptic Seizure Detection and Prediction using Electroencephalographic Signal" *Advances in Biomedical Research*.
[2]. "Research Priotities in Epilepsy for the Next Decade- A Representative view of the European Svientific Community". *Summary of the ILAE Epilepsy Research Workshop, Brussels, 17-18 January, 2008*.
[3]. Mormann F, Andrzejak RG, Elger CE, Lehnertz K, "Seizure prediction: the long and winding road", *Brain*.
[4]. Hopkins A, Scambler G. "How doctors deal with epilepsy", *Lancet*.
[5]. Iasemidis L, Pardalos P, Sackellares J and Shiau D, "Quadratic binary programming and dynamical system approach to the predictability of epileptic seizures" *j. Comb. Optim*.
[6]. A.Neligan, J.W. Sander, "The incidence and prevalence of epilepsy".
[7]. Aziz H, Guvener A, Akhtar SW, Hasan KZ, " Comparative epidemiology of epilepsy in Pakistan and Turkey: population-based studies using identical protocols" *Epilepsia*.
[8]. Nicoletti A, Reggio A, Bartoloni A et al. Prevalence of epilepsy in rural Bolivia: a door-to-door survey. *Neurology*.
[9]. Niedermeyer E, da Silva FHL, "Electroencephalography", Lippincott Williams & Wilkins.
[10]. Elger CE, Schmidt D, "Modern management of epilepsy: A practical approach" *Epilepsy & Behavior*.
[11]. A. Shoeb, J. Guttag, "Application of machine learning to epileptic seizure detection"
[12]. Noachtar S, Remi J, "The role of EEG in epilepsy: a critical review", *Epilepsy Behavior*.
[13]. R.G. Andrzejak, K. Lehnertz, F. Mormann, C. Rieke, P. David and C.E.Elger. "Indications of nonlinear deterministic and finite-dimensional structures in time series of brain electrical activity: Dependence on recording region and brain state", *Physical Review E vol 64*.
[14]. T. Fathima, M. Bedeeuzzaman, O. Farooq, Y.U. Khan, "Wavelets based features for epileptic seizure detection", *MES Journal of technology and management*.
[15]. Chua K.C, Chandran V, R. Acharya, Lim. C.M," Higher order spectral (HOS) analysis of epileptic EEG signals", *IEEE EMBS*.
[16]. Varotto G, Visani E, Franceschetti S, Sparacino G, Panzica F, "Spectral and coherence analysis of EEG during intermittent photic stimulation in patients with photosensitive epilepsy", *International journal of Bioelectromagnetism*.