Volume 2, Issue 4, April 2012 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Fast Fourier Transform Based Classification of Epileptic Seizure Using Artificial Neural Network

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***Abstract* - An epileptic seizure, occasionally referred to as a 'fit', is defined as a transient symptom of 'abnormal excessive or synchronous neuronal activity in the brain'. This paper proposed, classification of Epileptic Seizure based on Fast Fourier Transform (FFT). The classification is done by Artificial Neural Network (ANN) ; The FFT based features are extracted as an input to the neural networks. Here for experiment purpose Multilayer Percepron (MLP) and Generalized Feed Forward Neural Network (GFFNN) are used as a classifier. The results show that we are able to achieve 100% accuracy.**

Keywords - **Seizure, Electroencephalogram (EEG), Neural Network, MLP (Multilayer Perceptron), GFFNN (Generalized Feed Forward Neural Network), FFT (Fast Fourier Transform),MSE (Mean Square Error).**

I. Introduction

Epileptic Seizure is common neurological disorder. The medical syndrome of recurrent, unprovoked seizures is termed epilepsy, but seizures can occur in people who do not have epilepsy. The term 'Epilepsy' is derived from the Greek word epilambanein, which means 'to seize or attack'. Anything that disturbs the normal pattern of brain cells (neuron) activity from illness to brain damage to abnormal brain development - can lead to seizures. Having a seizure does not necessarily mean that a person has epilepsy. Only when a person has two or more seizures is he or she considered to have epilepsy. The seizure occurs at random to impair the normal function of the brain.

Epileptic Seizure are diagnosed by EEG signals, Electroencephalography (EEG) is the recording of electrical activity along the scalp. EEG measures voltage fluctuations resulting from ionic current flows within the neurons of the brain In neurology, the main diagnostic application of EEG is in the case of epilepsy, as epileptic activity can create clear abnormalities on a standard EEG study.[1]

The traditional methods of analysis being time consuming and tedious, there are many computer based diagnostic systems for epilepsy has been invented recently. Thasneem Fathima and Yusuf U. khan presents 'discriminant analysis for the detection of seizure' [2], Recently Dr. R. Shantha Selva Kumari, J. Prabin Jose proposed 'Time frequency analysis and SVM based seizure detection system' [3]. The method proposed by N. Sriraam et. al. [4] use recurrent neural network classifier with wavelet entropy and spectral entropy features as the input for the automated detection of epilepsy. N. Pradhan [5] Proposed 'Detection of seizure activity in EEG by an artificial neural network: A preliminary study'. L. Szilagyi proposed the recognition of of epileptic waveform by using the multi resolution wavelet decomposition of EEG signal [6]. The

epileptic seizure detection problem is modeled as two class classification problems. The two classes are Healthy subjects and second is interictal subjects (the person suffering from epilepsy). MLP and GFF-NN are designed and applied for the seizure detection. Fig. 1 shows the system diagram of proposed technique.

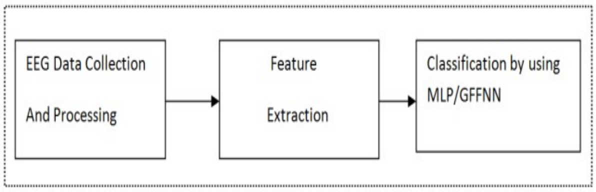

Fig.1 Flow chart of proposed system

II. Dataset Used

The EEG data considered for this work is extracted from University of Bonn EEG database which is available in public domain [4]. The complete database is comprised five set of dataset referred as A-E. Each dataset contains 100 single channel EEG segment without any artifacts with 23.6-sec. Set A and B contain recording obtained from surface EEG recording that were carried out on five healthy volunteers using a standardized 10-20 electrode placement scheme. Set C and D contained only activity measured during seizure free interval, segments in set D where recorded with in the epileptognic zone and those in the set C from the hippocampal formation of apposite hemisphere of the brain. Set E only contain the seizure activity.All signals were recorded with 128-channel amplifier system, using an average common reference. After 12 bit analog-to-digital conversion, the data were written continuously onto the disk of a data acquisition computer system at sampling rate of 173.61 Hz. Band pass filter setting were 0.53-40 Hz. Two sets of EEG data have been selected for the further experimentation, set A for healthy subject and set D for epileptic subjects during a seizure free interval that indicates interictal activity.

III. DESIGNED OF MLP AND GFFNN

Artificial Neural network is a powerful data modeling tool that is able to capture and represent complex input/output relationships. In other way ANNs are distributed, adaptive, generally nonlinear machines built from many different processing elements (PEs). Each PE gets connection from other PEs and/or itself. The interconnectivity defines topology. The Neural Network can be used for different purpose like Function approximation, Classifier, Time series Prediction, Data mining and processing. In this paper, we have used GFFNN and MLP neural network as a classifier.

A. MLP

Multilayer perceptrons (MLPs) are layered feed forward networks typically trained with static back propagation. These networks have found their way into countless applications requiring static pattern classification. Their main advantage is that they are easy to use, and that they can approximate any input/output map.

1) Experimental result:

The following graphs (Fig-2 and Fig-3) shows variations accuracy and Average MSE of various Transfer Functions respectively. The average classification accuracy and MSE are found to be best for Tanh Axon. The graph (Fig-4 and Fig-5) shows variations in average classification accuracy and MSE with various Learning Rules respectively. Here Momentum having better result as compare to other learning rules.

The various parameters selected for the MLP are as follows.

Tag data=10% for Cross Validation,
90% for Training.
Number of hidden layer used- 01
Number of processing elements in hidden layer are (PEs)- 17,
Transfer function used- Tanh Axon
Learning Rule used- Momentum
Cross Validation = 93.75%
Training= 100%.
Average MSE:-
Cross Validation = 0.028
Training=0.0009

B. GFFNN

Generalized feed forward networks are a generalization of the MLP such that connections can jump over one or more layers. In theory, a MLP can solve any problem that a generalized feed forward network can solve. In practice, however, generalized feed forward networks often solve the problem much more efficiently. A classic example of this is the two spiral problem. Without describing the problem, it suffices to say that a standard MLP requires hundreds of times more training epochs than the generalized feed forward network containing the same number of processing elements.

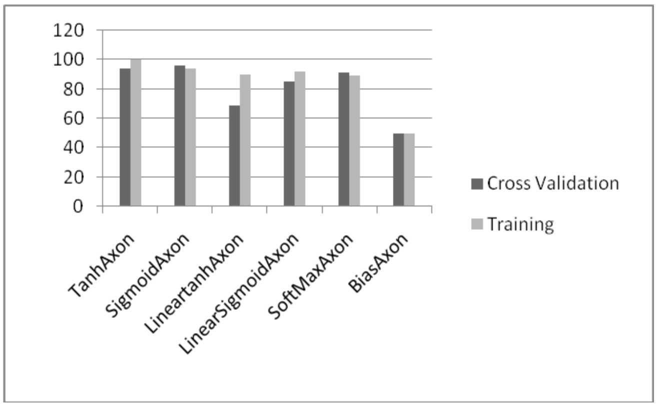

Fig. 2. Variation of % average classification accuracy with Transfer Function for MLP

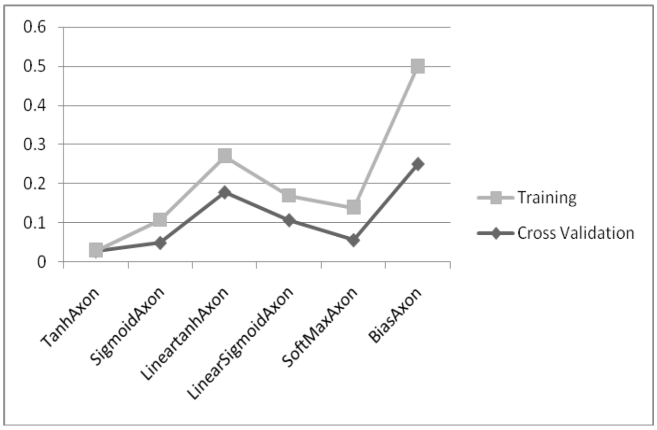

Fig. 3. Variation of average minimum MSE with Transfer function for MLP

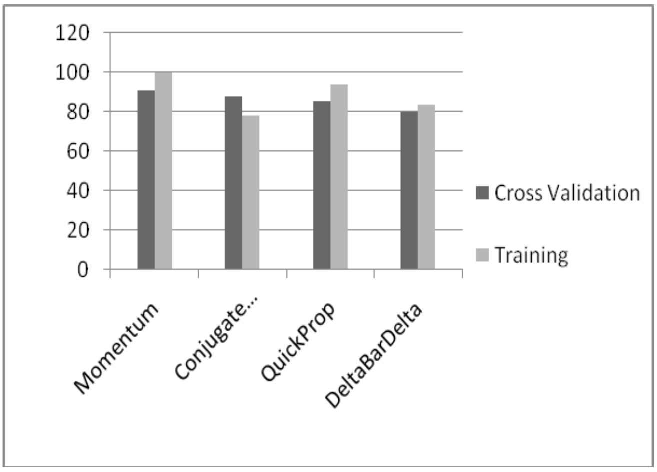

Fig. 4. Variation of % average classification accuracy with Learning Rule for MLP

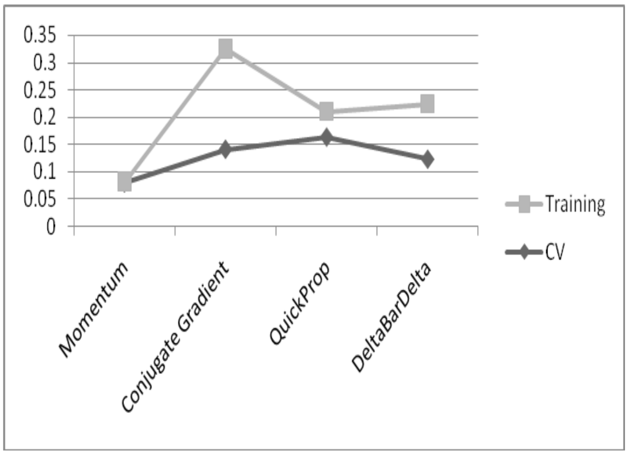

Fig. 5. Variation of average minimum MSE with Learning Rule for MLP

2) Experimental result:

The following graphs (Fig-6 and Fig-7) shows variations in average classification accuracy and MSE with the various Transfer Functions respectively. It is observed that Tanh Axon gives the better result as compare to other Transfer function. Similarly the graph (Fig-9 and Fig-10) shows variations in average classification accuracy and average MSE with the various Learning Rules respectively. It is observed that Momentum gives better performance compare to other learning rule.

The various parameters selected for the MLP are as follows.

Tag data=10% Cross Validation, 90% Training.

Number of hidden layer used - 01

Umber of processing elements used in hidden layer are (PEs) - 7,

Transfer function used- Tanh xon

Learning Rule used- Momentum

Cross Validation = 100%

Training= 99.45%.

Average MSE:-

Cross Validation = 0.008

Training=0.006

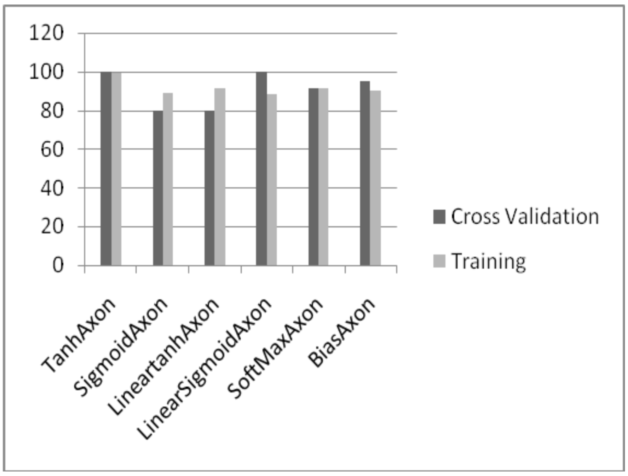

Fig. 6. Variation of % average classification accuracy with Transfer Function for GFFNN

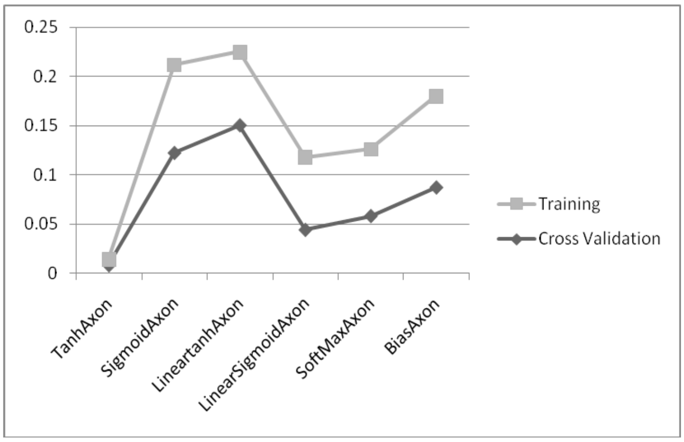

Fig. 7. Variation of average minimum MSE with Transfer function for GFFNN

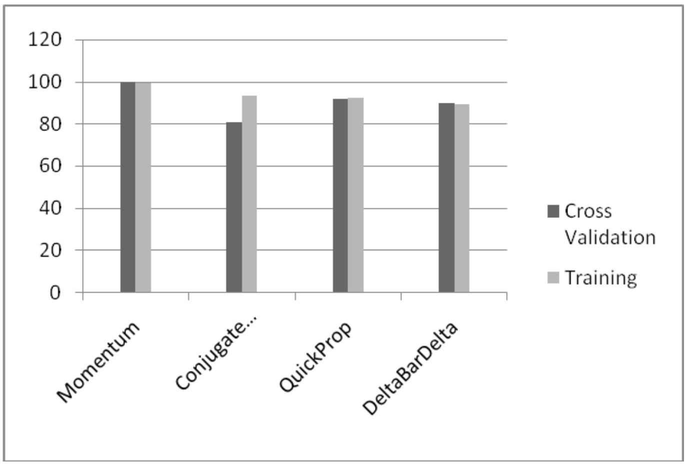

Fig. 8. Variation of % average classification accuracy with Learning Rule for GFFNN.

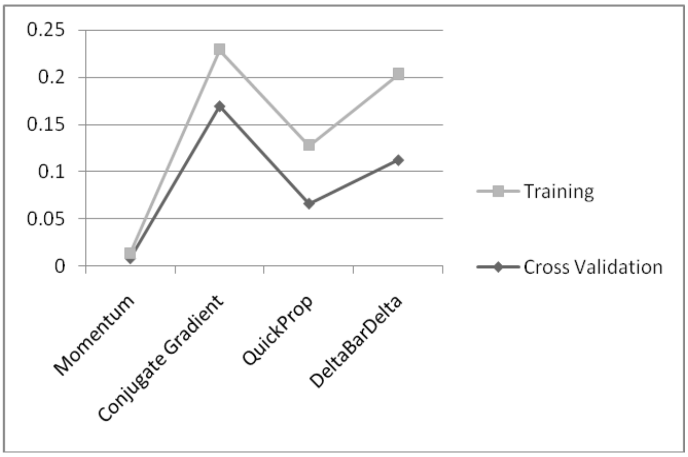

Fig. 9. Variation of average minimum MSE with Learning Rule for GFFNN

IV. CONCLUSION

This paper proposes the seizure detection based on neural network for that purpose we have designed and tested optimum MLP and GFF-NN. The training N times method is used for training the neural network to avoid any kind by biasing. With the reparative experimentation and variation in parameter of neural network the optimum MLP and GFF_NN are designed and tested on CV and training dataset. Table I shows the performance parameter comparison of MLP and GFFNN. The average classification accuracy obtained for MLP is 93.75% for CV dataset and 100 for training dataset and for GFF-NN it is 100% for CV dataset and 99.45% for training dataset. It is observed that the overall accuracy for GFFNN is 100% as compared to the overall accuracy of MLP which is 90%. So it is conclude that the GFF-NN is best as compared to MLP for the detection of epileptic seizure.

TABLE I
PERFORMANCE PARAMETER FOR MLP AND GFFNN

Neural Network	Average MSE		% Average Classification Accuracy		% Overall Accuracy	% Sensitivity	% Specificity
	Training	CV	Training	CV			
MLP	0.0009	0.08	90.9	100	90.0	81.81	100
GFFNN	0.006	0.008	99.45	100	100	100	100

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