

Epileptic Seizure Detection by Using Wavelet Transform and Neural Networks

Dr. Pravin A. Kharat¹, Ashwini P. Kharat², S.L. Farpat³

¹Associate professor, CSE Department, Padm. Dr. V. B. Kolte college of engineering, Malkapur

²Assistant Professor, SPCOE Dumberwadi(Otur) SIPNA'S College of Engineering Amravati

³Assistant Professor, CSE Department Padm. Dr. V. B. Kolte college of engineering, Malkapur

ABSTRACT

A seizure is usually defined as a sudden alteration of behavior due to a temporary change in the electrical functioning of the brain. Epilepsy is common neurological disorder that is characterized by recurrent unprovoked seizures. Epilepsy can develop in any person at any age. 0.5% to 2% of people will develop epilepsy during their lifetime. About 2.7 million Americans have been treated for epilepsy in the past 5 years. Diagnosis of seizure or epilepsy is highly risky because it requires continuous monitoring as well as full concentration towards signals. In this paper the authors presents automated diagnosis of epileptic seizure by using artificial neural networks. The wavelet transformed based features are extracted as an input to the neural networks. Multilayer Perceptron (MLP) and Generalized Feed Forward Neural Network (GFF-NN) are designed to classify the epileptic seizure. The result shows that we are able to achieve 100% accuracy.

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

1. INTRODUCTION

A seizure is a sudden surge of electrical activity in the brain that usually affects how a person feels or acts for a short time. Seizures are not a disease in themselves. Instead, they are a symptom of many different disorders that can affect the brain. The seizures in epilepsy may be related to a brain injury or a family tendency, but often the cause is completely unknown. The word "epilepsy" does not indicate anything about the cause or severity of the person's seizures. Epilepsy is a neurological condition, which affects the nervous system. Epilepsy is also known as a seizure disorder. It is usually diagnosed after a person has had at least two seizures that were not caused by some known medical condition like alcohol withdrawal or extremely low blood sugar.

Common seizures causes include things like fever, chemical imbalance (such as low blood sugar in people with diabetes), trauma, and developmental problems. Certain types of poisoning have also been known to lead to seizures. Other causes may involve brain tumors, alcoholism, and strokes. In about half of all cases, the cause is unknown. Epilepsy can develop in any person at any age. 0.5% to 2% of people will develop epilepsy during their lifetime. Out of 60,000 people filling a big stadium, about 500 have epilepsy. More men than women have epilepsy.

Researchers proposed many automatic systems for the diagnosis of epilepsy. M. Akin developed a classification method for the diagnosis [1]. Another work [2] recommended the recognition of epileptic waveform by using the multi-resolution wavelet decomposition of EEG signal. Vairavan Shrinivasan designed the approximate entropy based Elman neural network and probabilistic neural network for detection of epilepsy [3]. The method proposed by N. Sriraam et. al. [5] use recurrent neural network classifier with wavelet entropy and spectral entropy features as the input for the automated detection of epilepsy.

The epileptic seizure detection problem is modeled as two class classification problem. The two classes are Normal subjects and second is Epileptic subjects (the person suffering from epilepsy). MLP and GFF-NN are designed and applied for the seizure detection.

This paper is organized as follows in section-I we have discussed about the data set used. In section-II the information about neural network is given. In section III the designed procedure of MLP and GFF-NN is given. Finally the result and conclusion are given in the section-IV.

2. BENCHMARK EEG DATASE

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 epileptogenic 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.

3. NEURL NETWORK

Neural network is nothing more than a function with adjustable or tunable parameters. Let the input to a neural network be denoted by x , a real-valued (row) vector of arbitrary dimensionality or length. As such, x is typically referred to as *input*, *input vector*, and sometimes, *pattern vector*. Typically, the length of vector x is said to be the *number of inputs* to the network. Let the network output be denoted by y , an approximation of the desired output y , also a real-valued vector having one or more components, and the *number of outputs* from the network. Generally, a neural network is a structure involving weighted interconnections among *neurons*, or *units*, which are most often nonlinear scalar transformations, but which can also be linear.

The characteristics of Generalized Neural Network are

- Highly parallel
 - Process information much more like the brain than a serial computer.
- Learning
- Very simple principles.
- Very complex behaviours.

The most important applications of artificial Neural Network are as follows

1. As powerful problem solvers.
2. As biological models.

- *Multilayer Perceptron (MLPs)*

Multilayer Perceptron (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. The key disadvantages are that they train slowly, and require lots of training data (typically three times more training samples than network weights).

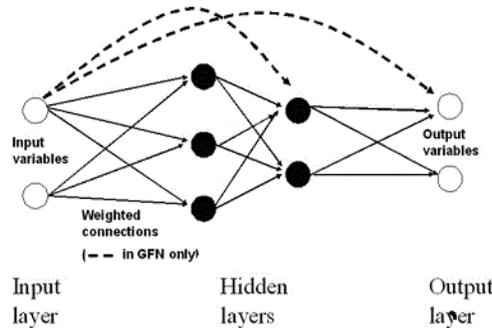


Fig. 1. Architectural model of GFFNN

- *Generalized feed forward Neural Network (GFF-NN)*

Generalized feed forward networks are a generalization of the Multilayer Perceptron (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.

4.DESIGNED OF MLP AND GFF-NN

Daubechies wavelets of different orders (2, 3, 4, 5, and 6) were investigated for the analysis of epileptic EEGs. This family of wavelets is known for its orthogonality property and efficient filter implementation. The second order Daubechies wavelet was found to be the most appropriate for analysis of epileptic EEG data. The original EEG signal is decomposed up to second level. At each level of approximation and details nine statistical parameters namely mean, median, mode, maximum, minimum, range, standard dev., median abs. dev. and mean abs. dev. are extracted. The new feature vector is formed by using these statistical parameters. The MLP and GFF-NN are trained by varying the number of hidden layers, PEs, number of exemplar used in training and CV, transfer function and learning rule to obtained the optimize NN. The network is trained three times. Average MSE on training and CV data set is measured and is indicated in fig. 2 to fig. 9 finally network is tested on training and cross validation dataset. To obtain the optimized MLP and GFF-NN the following parameters are selected.

TABLE 1
PERFORMANCE PARAMETERS FOR MLP AND GFF-NN

Parameter	MLP	GFF-NN
Exemplar for Training	90%	80%
Exemplar for cross validation	10%	20%
Number of inputs	36	36
Transfer Function Used	Tanh Axon	Linear Tanh Axon
Learning Rule Used	Momentum	Momentum
Average Classification Accuracy	Training-100% CV-100	Training-97.82% CV-100
Number of epoch	1000	1000

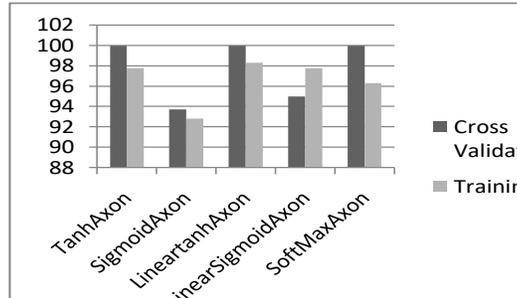


Fig. 2. Variation of % average classification accuracy with Transfer Function for MLP

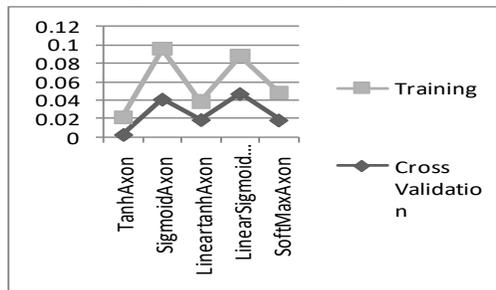


Fig. 3. Variation of average minimum MSE with Transfer function for MLP

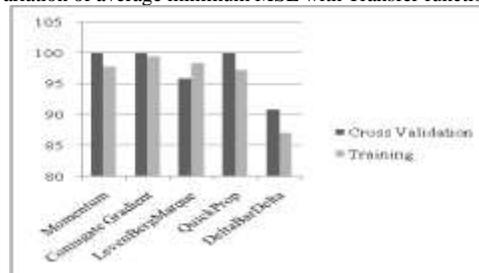


Fig. 4. Variation of % average classification accuracy with Learning Rule for MLP

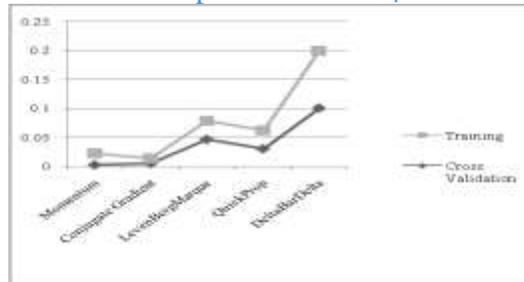


Fig.0 5. Variation of average minimum MSE with Learning Rule for MLP

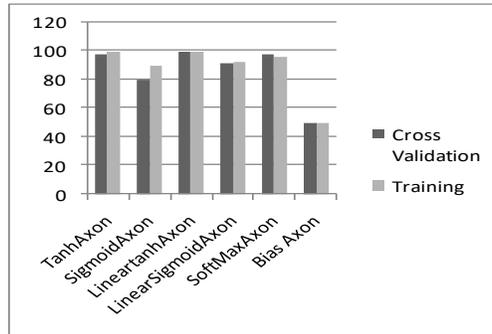


Fig. 6. Variation of % average classification accuracy with Transfer Function for GFF-NN

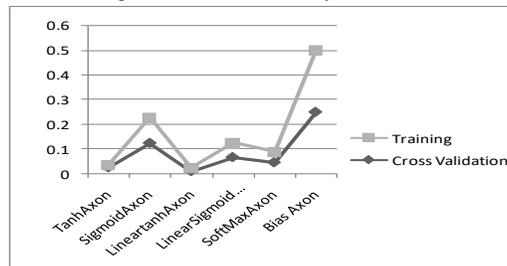


Fig. 7. Variation of average minimum MSE with Transfer function for GFF-NN

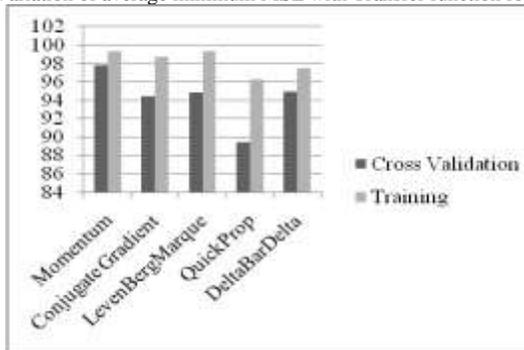


Fig. 8. Variation of % average classification accuracy with Learning Rule for GFF-NN

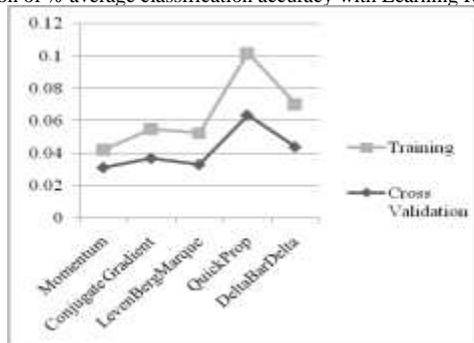


Fig. 9. Variation of average minimum MSE with Learning Rule for GFF-NN

TABLE 2

SENSITIVITY, SPECIFICITY AND OVERALL ACCURACY OF MLP

Performance Measure	Total Inputs	Correctly Classified	% result
Sensitivity	10	10	100
Specificity	10	10	100
Overall accuracy	20	20	100

TABLE 3

SENSITIVITY, SPECIFICITY AND OVERALL ACCURACY OF GFF-NN

Performance Measure	Total Inputs	Correctly Classified	% result
Sensitivity	23	22	95.65
Specificity	17	17	100
Overall accuracy	40	39	97.5

5. RESULT AND 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. The average classification accuracy obtained for MLP is 100% for CV dataset as well as training dataset and for GFF-NN it is 100% for CV dataset and 97.82% for training dataset. The performance parameters like sensitivity specificity and over all accuracy are shown in table 2 and table 3 for MLP and GFF-NN respectively. It is observed that the overall accuracy for MLP is 100% as compared to the overall accuracy of GFF-NN which is 97.5%. So it is conclude that the MLP is best as compared to GFF-NN for the detection of epileptic seizure.

6. REFERENCES

- [1] M. Akhil, M. A. Arserim, M. K. Kiyimik and I.Turkoglu “ A new approach for diagnosing epilepsy by using wavelet transform and neural network”, EMBS international conference Istanbul, Turkey October 2001.
- [2] L. Szilagyi. Z. Benyo and M. Szilagyi “A new method for epileptic waveform recognition using wavelet decomposition and artificial neural networks”, Proceedings of second joint EMBS/BMES conference Houston USA October 2002.
- [3] Vairavan Shrinivasan, Chikkannan Eswarann and Natarajan Sriraam, “Approximate entropy-based epileptic EEG detection using artificial neural network”, IEEE transaction on information technology in biomedicine vol. 11, No. 3, M ay 2007.
- [4] Ralph G. Andrzejak, Klaus Lehnertz, Florian Mormann, Christoph Rieke, Peter David and Christian E. Elger, “Indication of nonlinear deterministic and finite-dimensional structure in time series of brain electrical activity: Dependence on recording region and brain state”, Physical review E. volume 64,061907.
- [5] S. Pravin Kumar, N. Sriram, and P. G.Benakop “Automated detection of epileptic seizure using wavelet entropy feature with recurrent neural network classifier”, IEEE Region 10 conference, TENCON 2008.
- [6] V. Shrinivasan, C. Eswaran, N. Sriraam “Epileptic Detection using Artificial neural network”, International conferrance on signal processing and communication (SPCOM) IEEE 2004.