A RECURRENT ELMAN NEURAL NETWORK - BASED APPROACH TO DETECT THE PRESENCE OF EPILEPTIC ATTACK IN ELECTROENCEPHALOGRAM (EEG) SIGNALS

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ABSTRACT:

Epileptic attack persons are detected largely on the analysis of Electroencephalogram (EEG) signals. The EEG signals recordings generate very bulk data which require a skilled and careful analysis. This method can be automated based on Elman Neural Network by using a time frequency domain characteristics of EEG signal called Approximate Entropy (ApEn). This method consists of EEG collection of data, extraction and classification. EEG data from normal persons and epileptic affected persons was collected, digitized and then fed into the Elman neural network. This proposed system proposes a neural-network-based automated epileptic EEG detection system that uses approximate entropy (ApEn) as the input feature. Approximate Entropy (ApEn) [1] is a statistical parameter that measures the predictability of the current amplitude values of a physiological signal based on its previous amplitude values. It is known that the value of the Approximate Entropy drops sharply during an epileptic attack[2]and this fact is used in the proposed system. Type of a neural network namely, Elman neural network is considered in this paper. The experimental results portray that this proposed approach efficiently detects the presence of epileptic seizures[3] in EEG signals and showed a reasonable accuracy.

KEYWORDS: EEG Signals,Epileptic, Elman Neural Network, Approximate Entropy

INTRODUCTION:

Around 1% of the people in the world suffers from epilepsy [3]. The Electroencephalogram (EEG) signal is used for the purpose of the epileptic detection as it is a condition related to the brain’s electrical activity[4]. Epilepsy is characterized by the occurrence of recurrent seizures in the EEG signal. In majority of the cases, the onset of the attacks cannot be predicted in a short term, a continuous recording of the EEG is required to detect epilepsy. A common form of recording used for this purpose is an ambulatory recording that contains EEG data for a very long duration of even upto one week [8] .

It involves an expert’s efforts in analyzing the entire length of the EEG recordings to detect traces of epilepsy. As the traditional methods of analysis are tedious and time-consuming, many automated epileptic EEG detection systems have been developed in recent years. With the advent of technology, it is possible to store and process the EEG data digitally. The digital EEG data can be fed to an automated seizure detection system in order to detect the seizures present in the EEG data. Hence, the neurologist can treat more patients in a given time as the time taken to review the EEG data is reduced considerably due to automation. Automated diagnostic systems for epilepsy have been developed using different approaches. This paper discusses an automated epileptic EEG detection system using neural networks, namely, Elman neural network using a time-domain feature of the EEG signal called Approximate Entropy (ApEn)[5] that reflects the nonlinear dynamics of the brain activity. Approximate Entropy (ApEn) is a recently formulated statistical parameter to quantify the regularity of a time series data of physiological signals.

It was first proposed by Pincus[6] in 1991 and has been predominantly used in the analysis of the heart rate variability.Estimation of regularity in epileptic attack time series data, and in the estimation of the depth of anesthesia.Diambrahave shown that the value of the Approximate Entropy(ApEn) [7] drops abruptly due to the synchronous discharge of large groups of neurons during an epileptic activity. Hence, it is a good feature to make use of in the automated detection of epilepsy. In this paper, this feature is applied, for the first time, in the automated detection of epilepsy using neural networks.

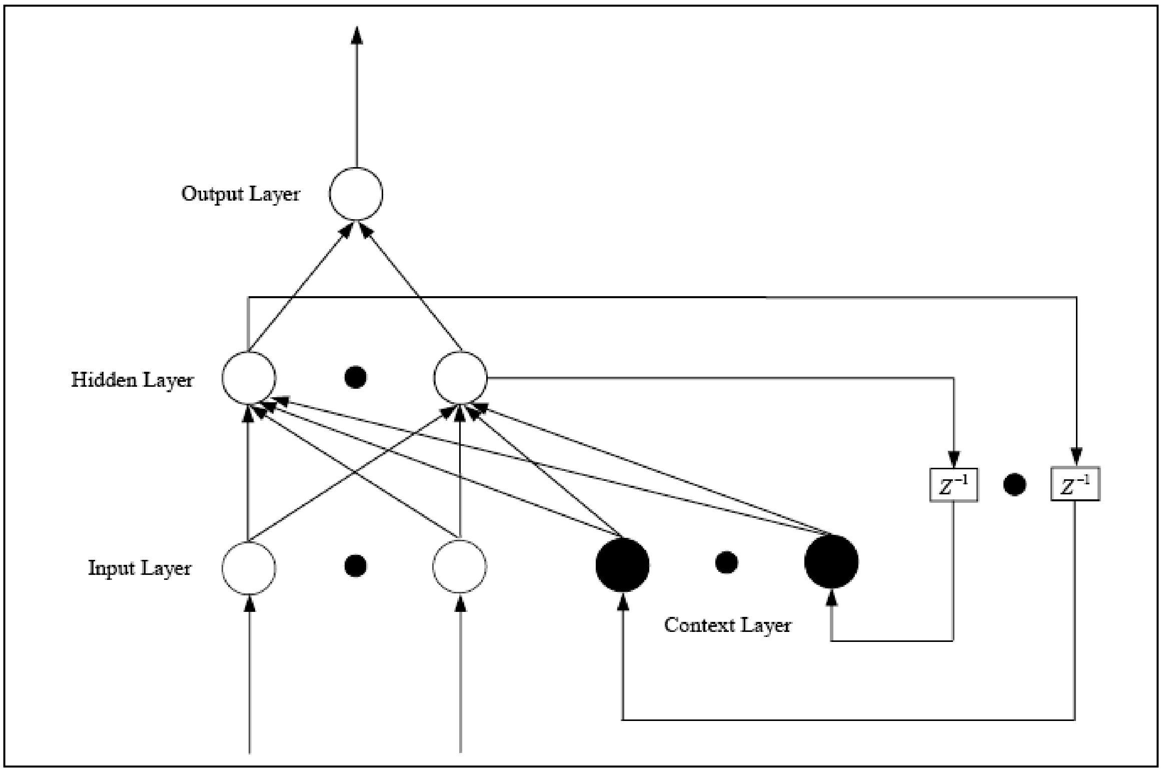
ELMAN NETWORK

It is a recurrent neural network with two layers the hidden layer and the output layer. It is a back propagation network with a feedback connection from the output of hidden layer to its input. This means that the function learnt by the network can be based on the current inputs plus a record of the previous states and outputs of the network. The spatial patterns and temporal patterns are recognized by the Elman Neural Network due to its feedback connection. The inputs for the neural network are the ApEn values corresponding to the normal and epileptic EEG signals. The ApEn values of epileptic patients have a little wide spike followed by abrupt fall in ApEn value.

Elman Neural Network is used to learn and detect this temporal pattern of ApEn values of epileptic patients. It detects the EEG signal without that particular temporal pattern as non-epileptic. The activation functions used for the two-layered ENN are tan-sigmoid and log-sigmoid for the hidden and output layers, respectively.90 hidden nodes and one output node is used. The training of the Elman Neural Network is done by using Resilient Back propagation. Train the network by using the target value 0 and 1 for normal EEG and epileptic EEG, respectively. The classification is done by using the range of values 0-0.3 for the normal EEG and 0.7- 1 for epileptic EEG. The MSE Error Goal is set to 0.01, which is sufficient for accurate classification.

An Elman Recurrent Neural Network is a network which in principle is set up as a regular feed forward network. This means that all neurons in one layer are connected with all neurons in the next layer. An exception is the so-called context layer which is a special case of a hidden layer. The neurons in the context layer (context neurons) hold a copy of the output of the hidden neurons. The output of each hidden neuron is copied into a specific neuron in the context layer. The value of the context neuron is used as an extra input signal for all the neurons in the hidden layer one time step later. Therefore, the Elman network has an explicit memory of one time lag (Elman, 1990). Similar to a regular feed forward neural network, the strength of all connections between neurons are indicated with a weight. Initially, all weight values are chosen randomly and are optimized during the stage of training.

FIG 1:STRUCTURE OF ELMAN NEURAL NETWORKS



where Z^{-1} is a unit delay.

METHODS

Two sets of EEG data of normal and epileptic subjects from 18 subjects is used. 10 subjects normal and epileptic EEG data is used for training and remaining was used for testing. The depth electrodes are placed symmetrically into the hippocampus formations and strip electrodes are placed onto the lateral and basal regions of the neocortex. The epileptic EEG signals are selected from all the recording sites exhibiting actual activity. The intracranial epileptic EEG has been chosen for this classification system as the intracranial recordings offer the most precise access to the emergence of seizure. EEG signal is recorded during the occurrence of the epileptic seizures from these intracranial electrodes. EEG signal of normal subjects are obtained using intracranial electrodes.

The EEG data acquired and recorded using Europhile NT Digital Video is grayscale, sampled at 256 Hz, and digitized into text files of peak values of 128 channels. A line noise of 50hz is present in the data is filtered out using a Notch filter at 50hz(49hz - 51hz).An optional band pass 0.53 to 40hz filter may be applied to increase sensitivity and remove unnecessary signal frequencies. Notch and Band pass Filter Order is found using Trial and Error method. The order of filter used is 3*ceil (sampling rate/lower cutoff frequency). Then EEG recordings are visually inspected for artifacts.

Table 1: EEG Records

SL NO	EEG RECORDED	SYMPTOMS
1	Fp1-F7	Normal
2	F7-T3	Normal
3	T3-T5	Epileptiform patterns
4	T5-O1	Epileptiform patterns
5	Fp1-F3	Normal
6	F3-C3	Normal
7	C3-P3	Epileptiform patterns
8	P3-O1	Epileptiform patterns
9	Fz-Cz	Normal
10	Cz-Pz	Epileptiform patterns
11	Fp2-F4	Normal
12	F4-C4	Normal
13	C4-P4	Epileptiform patterns
14	P4-O2	Epileptiform patterns
15	Fp2-F8	Normal
16	F8-T4	Normal
17	T4-T6	Epileptiform patterns
18	T6-O2	Epileptiform patterns

Fp1-f3 and Fp1-f7 refer to different electrode on an EEG, which is roughly correspond to the left frontal and prefrontal cortex regions. This region of the brain is involved in many areas of cognition, including short term memory storage and executive function. In referential montages, one of the electrodes in each pair is connected to a common electrode (e.g., channel 1: Fp1-A1; channel 2: F7-A1; channel 3: T3-A1; channel 4: T5-A1; channel 5: O1-A1). In bipolar montages, there is no common electrode. Bipolar montages are usually arranged in a chain with the same electrode in adjacent derivations (e.g., channel 1: Fp1-F7; channel 2: F7-T3; channel 3: T3-T5; channel 4: T5-01).

IMPLEMENTATION:

Implementation is the most critical step in achieving a successful system and giving the user's confidence that the new system is workable and very effective. This method of conversation is relatively very simple to handle, provided there are no major changes in the system. Each program is tested individually at the time of development using the data and has verified that this program linked together in the way specified in the programs specification, the computer system and its environment is tested to the satisfaction of the user.

The method that has been developed is accepted and proved to be satisfactory for the user. And so the system is going to be implemented very soon. A simple operating procedure is included so that the user can understand the different functions clearly and quickly. Initially as an initial step the executable form of the application is to be created and loaded in the common server machine which is accessible to the entire user and the server is to be connected to a network. The final stage is to document the entire system which provides components and the operating procedures of the system. Systems implementation is the construction of the new system and the delivery of that system into production.

Implementation is the carrying out, execution, or practice of a plan, a method, or any design for doing something. As such, implementation is the action that must follow any preliminary thinking in order for something to actually happen. In an information technology context, implementation encompasses all the processes involved in getting new software or hardware operating properly in its environment, including installation, configuration, running, testing, and making necessary changes. The word deployment is sometimes used to mean the same thing. Generally implementation of the software is considered as the actual creation of the software.

SUMMARY AND CONCLUSION

Elman Neural networks, have been employed for the automated detection of epilepsy. A robust and computationally low-intensive feature, namely, Approximate Entropy(ApEn) has been used for the proposed epileptic detection system. The experimental results portray that this proposed approach efficiently detects the presence of epileptic seizures in EEG signals and showed a reasonable accuracy. As the proposed system is based on a single feature that has a low computational burden, it is best suited for the real-time detection of epileptic seizures from ambulatory recordings.

Epilepsy is a common neurological disorder not a disease which is not contagious, fainting disorder and cause mental illness. Epileptic person has a tendency to have recurrent seizures which produces nonlinear dynamic system. By using Elman Neural Network and Approximate Entropy(ApEn) as an input feature for implementation of detection of epilepsy. Since, it is using a single input feature so that's why we having low computational burden and best suited for the real-time detection of epileptic seizures. We described one kind of Artificial Neural Network (ANN) and conception how to implement it. Though the use of Artificial Neural Networks(ANNs) increases the computational complexity, the high overall detection accuracies expected from this system surpasses its disadvantage as in any automated attack detection system, since the detection of the attack with high accuracy is of primary importance. This is because it is known that Approximate Entropy (ApEn) [7] possesses good characteristics such as robustness in the characterization of the epileptic patterns and low computational burden. Hence, an automated system using Approximate Entropy (ApEn) as the input feature is best suited for the real time detection of the epileptic attack.

REFERENCE:

[1] V. Srinivasan, C. Eswaran, and N. Sriraam, "Approximateentropybased epileptic EEG detection using artificial neuralnetworks," IEEE Transactions on Information Technology inBiomedicine, vol. 11, no. 3, pp. 288–295, May 2007.

[2] K. Lehnertz, F. Mormann, T. Kreuz, R. Andrzejak, C. Rieke,P. David, and C. Elger, "Seizure prediction by nonlinear EEGanalysis," IEEE Engineering in Medicine and Biology Magazine, 2003

[3] Atlas: Epilepsy Care in the World. World HealthOrganization, 2005.

[4] S. M. Pincus, T. R. Cummins, and G. G. Haddad, "Heart ratecontrol in normal and aborted SIDS infants," Amer. J.Physiol., vol. 264, no. 3, pp. R638–R646, 1993.

[5] N. Mc Grogan "Neural network detection of epilepticseizures in the lectroencephalogram",[Online]. Available:http://www.new.ox.ac.uk/˜nmcgroga/work/transfer

[6] T. S.Walczak, P. Jayakar, and E. M. Mizrahi, Epilepsy: A Comprehensive Textbook, 2nd ed. Lippincott Williams & Wilkins, 2008, ch. 73, pp. 809 – 813.

[7] J. Bruhn, H. Ropcke, and A. Hoeft, "Approximate entropy as an electroencephalographic measure of anesthetic drug effect during desflurane anesthesia," Anesthesiology, vol. 92, pp. 715–726, 2000

[8] R. Flink, B. Pedersen, A. B. Guekht, K. Malmgren, R. Michelucci, B. Neville, F. Pinto, U. Stephani, and C. Ozkara, "Guidelines for the use of EEG methodology in the diagnosis of epilepsy international league against epilepsy," Acta Neurologica Scandinavica, vol. 106, 2002.