ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 7, July 2015

Hybrid Model for Classification and Detection of Neurological Disorders

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Abstract: The hybrid model designed in this paper is used to detect the neurological disorders like focal epilepsy brain death and various other EEG signals. In order to detect such signals the hybrid model consists of three major modules. The modules designed are for feature extraction of the signals, training and testing of the signals using ANN and the fuzzy logic model. Burg algorithm is used for feature extraction, BPNN is used for training and testing of the signals and sugeno fuzzy model is used for giving more précised results.

Keywords: EEG signals, Burg algorithm, BPNN, Sugeno fuzzy model.

I. INTRODUCTION

Human brain processes sensory information received by external and internal stimuli. It controls movement and regulates cognitive functions such as thinking, learning, remembering, speaking, and decision making. The brain consists of perhaps 100 billion or more nerve cells called neurons.

The electrical nature of the human nervous system has been recognized for more than a century. It is well known that the variation of the surface potential distribution on the scalp reflects functional activities emerging from the underlying brain The electroencephalogram (EEG) is a recording of the electrical activity of the brain from the scalp. The recorded waveforms reflect the cortical electrical activity. Electroencephalogram (EEG) signals provide one possible means of human–computer interaction, which requires very little in terms of physical abilities. Every neuron has thousands of interconnections among them. Interconnected neurons are responsible for higher order thinking, complex behavior, and it provides us with the ability to perceive, understand, and react to environmental events. The human brain is an organic electrochemical computer as neurons exploit chemical reactions to generate electricity. The electrochemical nature of neurons gives rise to our actions, our modes, and our behavior. When a neuron becomes excited it passes electro-chemical impulses incoming from the dendrites along the axon to communicate with other neurons in the brain.
These signals are recorded with the help of RMS machine and the filtering is done by the RMS software. The filter used by the software is notch filter.

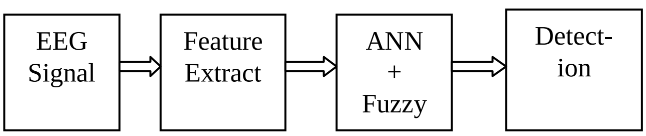
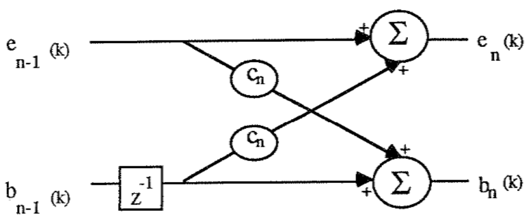


Fig. 1

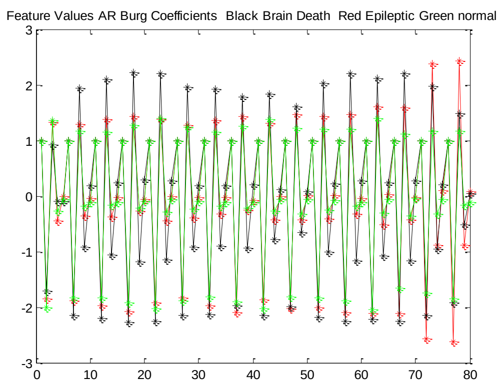
This figure shows the proposed block diagram of the system. It consist of feature extraction, Artificial Neural Network (ANN) and Fuzzy Logic. Then the neurological disorder is detected.

II. FEATURE EXTRACTION

The feature extraction has been done by using the burg algorithm[11].
The figure below shows the lattice structure used in the burg algorithm along with the formula for the correlation coefficient.



$$c_n = -2\frac{\sum_{k=n}^{M} e_{n-1}(k) \cdot b_{n-1}(k-1)}{\sum_{k=n}^{M} e_{n-1}^{2}(k) + b_{n-1}^{2}(k-1)}$$



DOI 10.17148/IJARCCE.2015.4757

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 7, July 2015

The above figure shows the plot for the extracted features of the EEG signals. As from the figure we can see that the spikes of brain death signal are the highest i.e the value of the features of brain death features are much more than the epileptic and the normal signals.

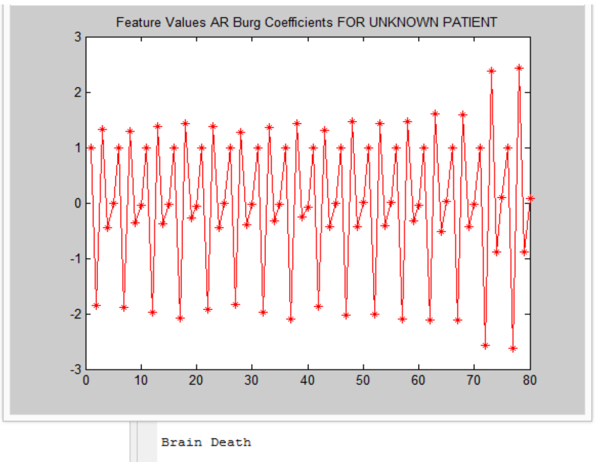
III. BACK-PROPAGATION NEURAL NETWORK

The next step is to train the artificial neural network. The neural network used is back propagation neural network. In back propagation neural network the input is given through the forward path and the weights of the neurons are updated by the backward path. As the updation of the weights are done by the backward path hence it is known as back propagation neural network.

The BPNN is first provided with the samples corresponding to each type of signals. for example [1 0 0] is used for epileptic signal, [0 1 0] is used for brain death signal and [0 0 1] is used for the normal signal. This indicates that the 3*3 matrix is used for 3 no. of patients. If we generalize this, then for 'N' number of patients, 'N*N' matrix is used. This matrix is used as the target for the neural network. Hence, keeping in mind these targets, the training of neural network is done. After the training of BPNN, the result is then saved in matrix format.

Then the testing of the unknown signal is done using BPNN. For testing, the features of that unknown signal is extracted first. These features are then given to the BPNN as the input pattern and is then compared with the target pattern which was used for the training of BPNN. After the comparison is done, the plot of the result is shown that indicates the type of signal the unknown signal belongs.

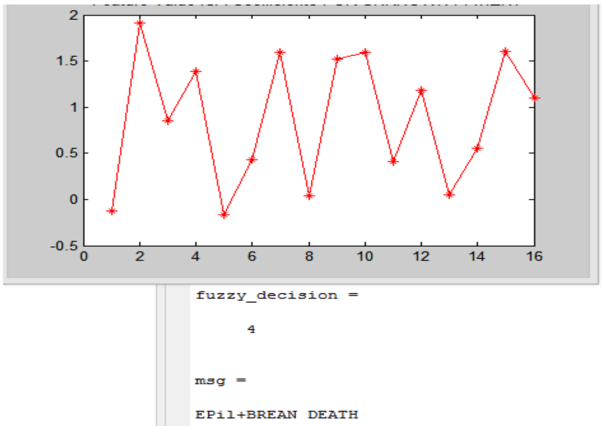
The below figure shows the plot of the unknown signal after testing it by the BPNN. The figure also shows that the signal is of brain death type.



IV. SUGENO FUZZY MODEL

The fuzzy model is used for giving us the more précised results. If a signal contains the features of two or more types of signals, then the result given by the BPNN may be incorrect or the neural network might not be able to properly detect the exact type of the unknown signal. In such cases, the fuzzy model is used in order to give the required precision to our result. Basically there are two types of fuzzy models. The fuzzy model used in this paper is sugeno. It is most widely used fuzzy model.

The rule base is first designed in the fuzzy model. Then according to this rule base, the fuzzy decision is made for the type of unknown signal. The below figure is the output plot given after the fuzzy decision.



V. CONCLUSION

Thus this paper gives us an idea about the algorithm that can be used for the detection of neurological disorders with précised results.

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