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Feature Extraction of EEG Signals by Auto-Regression.

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Abstract— In order to study the EEG signals, the feature extraction of the signals is very important. There are parametric and non-parametric methods of feature extraction. In this paper we are using auto-regression model for feature extraction, which belongs to the parametric methods. For feature extraction we have collected the real time EEG signals from the hospital, rather than taking the online data. There are two types of autoregressive modeling i.e. Yule-Walker algorithm and Burg algorithm. This paper uses the burg algorithm for feature extraction of EEG signals.

Keywords- *EEG signals, feature extraction, real time data, parametric method, auto regression, Burg algorithm*

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I. Introduction

The study of EEG signals in biomedical field is growing day by day. In order to study these signals properly, it is very important to extract all the features of the signals.

There are two types of methods of feature extraction. The first method is parametric method and the second method is non-parametric method. This paper gives an idea about one of the parametric method of feature extraction on EEG signals.

The block diagram shown below, gives an idea about the major steps followed during the process.

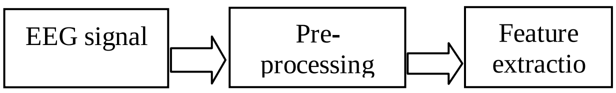


Figure: (a) Block Diagram.

II. EEG signals

The first and foremost step was to collect the EEG signals. Mostly the modified data or the data available on internet. For our work, we have collected true data from various hospitals. Electroencephalogram (EEG) is nothing but the recordings taken from the human brain. For the detection of any abnormality in human brain signals, only visual analysis is not sufficient. Hence, it is important to study the EEG signals of that brain. The EEG spectrum gives the characteristic

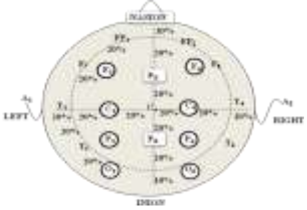
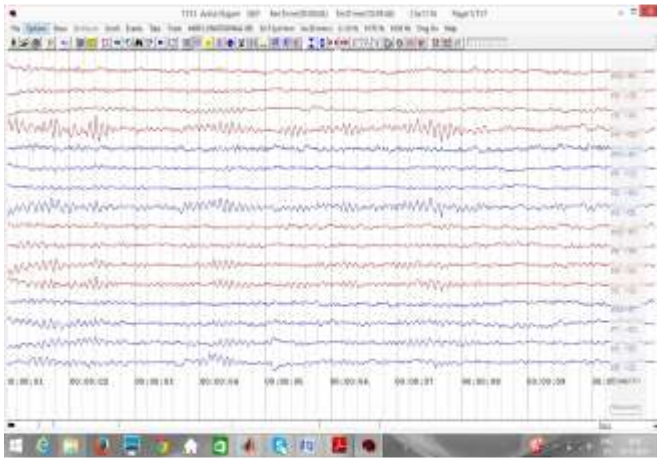


Figure: (b) Placement of Electrodes

waveforms in various frequency bands. These bands are: 1-4 Hz (delta), 4-8 Hz (theta), 8-13 Hz (alpha), 13-30Hz (beta). The EEG signal acquisition is done by the RMS machine. There are 32 electrode club in the pair of 2, which results in 16 electrodes. These electrodes are placed on the skull of the patient as shown in figure: (b) The RMS machine works at 256 Hz. The readings from the electrodes are taken for 30 monutes.



III. Pre-processing

The electrodes placed on the skull of the patient takes the electrical signals and these electrical signals are then represented in the waveform pattern by the RMS machine. The each pair of electrode gives the average value of both the electrodes.

In pre-processing part, the signals recorded from the electrodes are converted into the excel format. This is done by the RMS software. The software takes the magnitude of the waveforms and converts it into the mathematical values. Now,

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these mathematical values can be used for the feature extraction purpose.

IV. FEATURE EXTRACTION.

There are two types of feature extraction techniques: parametric method and non-parametric method. In this paper we are using the parametric method of feature extraction. The parametric method gives us the parameters of the EEG signals that can be further used for the detection of abnormalities.

The auto-regression method is of parametric type of feature extraction method. There are two types of AR modeling styles: Yule-Walker algorithm and Burg algorithm. The burg algorithm has already been proved the best for AR modeling and the yule-walker algorithm was discarded[9]. The accuracy of burg algorithm was much better than the yule-walker algorithm.

Burg Algorithm: There are many ways of designing the AR model. We are using the Burg algorithm. The Burg algorithm uses the lattice filter structure in order to minimize the forward prediction error and reverse prediction error. The structure given below shows the lattice filter of burg algorithm .The burg algorithm provides us the AR model for the various data samples. The estimate is given by A(Z).

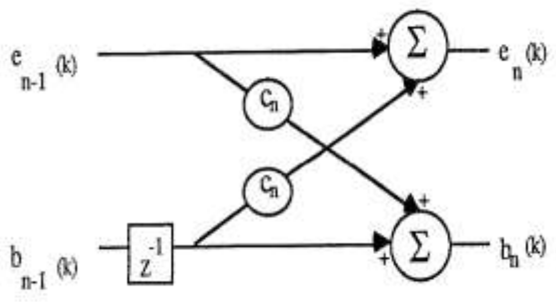

Figure:(c) Lattice Filter Structure

Where: $e_n(k)$ is the forward prediction error,

$b_n(k)$ is the backward prediction error

& c_n is called as the reflection co-efficient.

- The forward prediction error is given by the equation:

  $e_n(k) = e_{n-1}(k) + c_n b_{n-1}(k-1)$

- The backward prediction error is given by the equation:

  $b_n(k) = c_n e_{n-1}(k) + b_{n-1}(k-1)$

- The equation of reflection co-efficient is given by:

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

Where: M is the number of data samples.

In Burg algorithm we have to minimize the reflection co-efficient in such a way that the number of data samples obtained should be finite.

Hence, the AR parameters can b obtained by

$a_n = c_n$

This algorithm was implemented in MATLAB. First step is to load the EEG data file in .MAT format. Then the mathematical values recorded by all the electrodes are taken and these values are used to extract the required features. These features are extracted by calling the function for burg algorithm that performs the calculations given by the various equations given previously. These features are then saved in the variables separately. Then these features extracted from each electrodes are integrated together and saved in a variable. Then these integrated features are then plotted and observed.

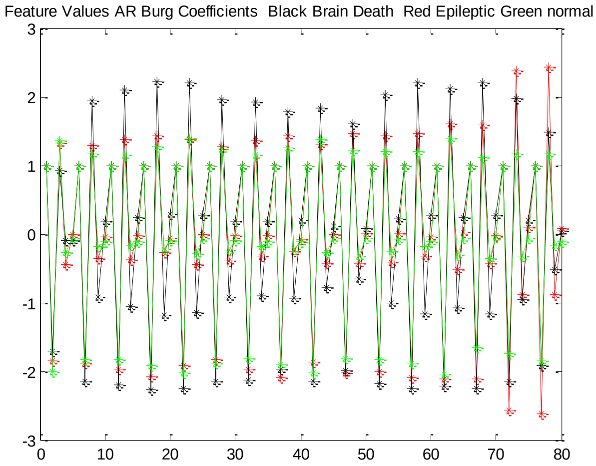

Figure:(d) MATLAB output

The above figure shows the output observed after implementing the Burg algorithm. The waveform contains the plot of all the features extracted from the EEG signals. The black waveform is for the EEG signal of the brain death patient, the red waveform is of general epileptic patient and the green waveform is of normal patient. Thus by observing the above figure we can compare the features of the EEG signals of patients suffering from different types of diseases.

V. CONCLUSION.

Thus in this way by implementing the Burg algorithm, we found that this method is also an efficient feature extraction technique. Hence, the features extracted by this method can further be used for classification and the detection of neurological disorders.

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