DWT and ANN Based Heart Arrhythmia Disease Diagnosis from MIT-BIH ECG Signal Data

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***Abstract*—**Diagnosis of heart disease is complex. ECG plays an important role for analysis and diagnosis of heart disease. Normally ECG signals are affected by different noises. These noises pollute the ECG signal. For quality diagnosis it is necessary to de noise the ECG signal. After de noising ECG signals, a pure signal is used to detect ECG parameters. Detection of ECG parameters takes an important role in the analysis of ECG signal. The Feature extracted ECG signal applied to ANN for classification to detect cardiac arrhythmia. This paper introduces the Electrocardiogram (ECG) pattern recognition method based on wavelet transform and neural network technique with error back propagation method has been used to classify two different types of arrhythmias, namely, Left bundle branch block (LBBB), Right bundle Branch block (RBBB) with normal ECG signal. The MIT-BIH arrhythmias ECG Database has been used for training and testing our neural network based classifier. The simulation results shown at the end.

Keywords- *ECG, DWT, ANN, RBBB, LBBB, Arrhythmia.*

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I. INTRODUCTION

In recent years, computer assisted ECG interpretation has played an important role in automatic diagnosis of heart anomalies. ECG is the recording of the electrical activity of the heart, and has become one of the most important tools in the diagnosis of heart diseases. ECG plays an important role in the clinical diagnosis of the heart disease. It provides an objective indicator for correct analysis, diagnosis, treatment and care of the heart disease. Any change in ECG parameters indicates an illness of the heart. The performance of ECG classification strongly depends on the characterization power of the features extracted from the ECG data and the design of the classifier. The paper describes preprocessing, Feature extraction and Classification of ECG signal. In the pre-processing, step first raw ECG signals are converted in to its physical unit's then noise and interference is removed by wave let technique called as preprocessed ECG signal. For Feature extraction, the FV (DWT -Coefficients)are detected by DWT technique. The Classification of ECG signal is done by using ANN. Artificial neural network technique with error back propagation method has been used to classify two different types of arrhythmias, namely, RBBB, LBBB with normal ECG signal. The classification is done by taking FV (DWT coefficients) of recorded ECG signalThe MIT-BIH arrhythmias Database has been used for training and testing our neural network based classifier. The simulation results are shown at the end for normal and two arrhythmias.

II. ECG PRE-PROCESSING

The MIT/BIH ECG arrhythmiadata base contains 48 records each containing two channel ECG signals for 30 minutes duration selected from 24 Hr. recordings of 47 individuals. Continuous ECG signals are band pass - filtered at .1-100 Hz. and digitized at 360 Hz.In most records, the upper signal is a modified limb lead II (MLII), obtained by placing the electrodes on the chest. Each record in the MIT/BIH database has an annotation file in which each ECG beat has been identified by the expert cardiologist. These labels are used in training the classifiers and also to evaluate the performance of the classifiers in testing phase. The availability of annotated MIT/BIH database has enabled the evaluation of performance of the proposed classification algorithm.

ECG signal contains several kinds of noise, such as power line interference, baseline wandering,and electromyography noise, which can affect the extraction of parameters. The Low and high pass filters are used for drift, high frequency noise and line base suppression. Time frequency methods, based on the Discrete Wavelet Transform (DWT) and thresholding coefficients are applied to de-noising ECG signals; the algorithm for de-noising ECG by DWT is to decompose the signal in approximation and detail coefficients.

III. FEATURE EXTRACTIO OF ECG SIGNAL

In feature extraction of ECG signal, initially R peaks are detected. Approximately 150 samples are selected after R

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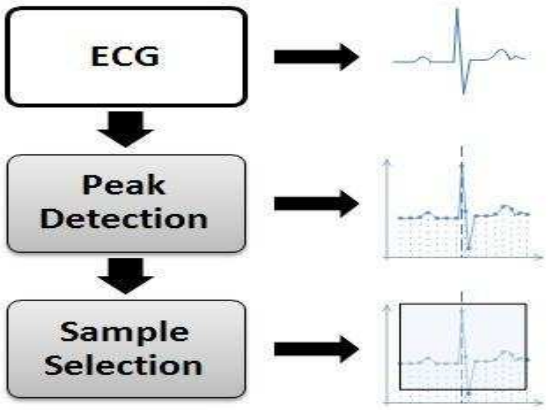
wave for all types of signals called segments. The selected samples are submitted to DWT which produces wave coefficients. They create feature vector which will be processed by artificial neural network technique with error back propagation method to classify cardiac arrhythmia.

Detection of R peaks and sample selection by using DWT

- Sample selection



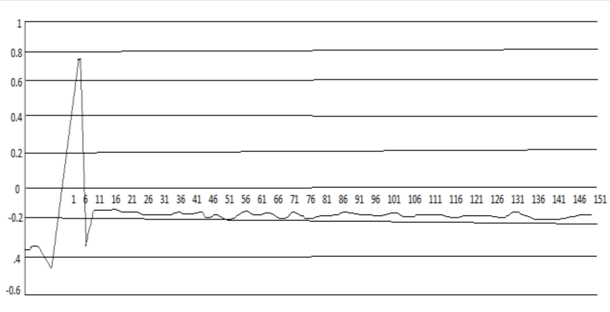


Fig.7:- Samples of the original ECG signal

Process starts by segmenting the entire database. Normally, first step in segmentation is the cardiac peaks detection. But, the MIT-BIH is already annotated. For each cardiac beat, one hundred and fifty samples were selected, after R wave for all types of signals. This interval contains the most relevant waves for the arrhythmia detection method.

The samples selected are submitted to a Wavelet transform, for feature extraction process. We used a Discrete Wavelet transform called Coiflet, with 4 levels of resolutions. The Wavelet transform produces the Wavelet coefficients (one coefficient for each sample). They create the feature vector that will be processed by the ANN.

- ***ECG pattern Generation***

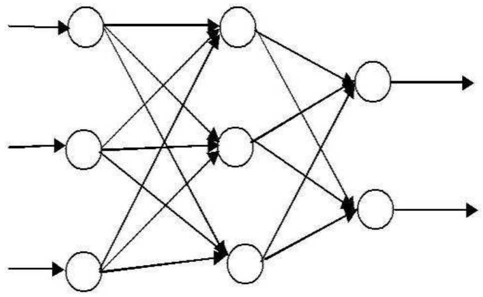
The paper represents three different types of ECG signals whichare statistically classified as NORMAL, RBBB, and LBBB. The maximum value of these parameters (Feature Vector) of these ECG signal are called as ECG patterns. These patterns are then applied to ANN as training and testing data. Also, these parameters are considered as neurons in ANN. The neurons in a feed forward neural network are organized as a layered structure and connected in a strictly feed forward manner Following are the details of ECG patterns signal used for classification of ECG signal

1) Number of samples of ECG signal =150 from R peak

2) Number of different types of ECG signal = 03

3) Number of cycles of ECG signal = 10

IV. ANN BASED CLASSIFICATION OF ECG.



Input Layer   Hidden Layer   Output Layer

Figure shows the BP neural network structure. Artificial Neural Network is biologically inspired network that are suitable for classification of biomedical data. A combination of DWT and ANNs is proposed to classify cardiac arrhythmias. The precision of classification results of the anomalies depends on the number of parameters selected; the number of neurons of input layer is equals to the numbers of parameters used for classification. The parameters extracted are used to train the ANNs. Typically, for classification, the configuration usually used are multilayer feed forward neural networks with Log-sigmoid activation function that using the generalized back propagation for training which minimize the squared error between the desired outputs and the actual outputs of the ANNs. The three nodes of the BP network is represented as: input node ^{xj} , hidden node ^{yi} , output node ^{j} , network weight of input node ^{wig} , network weight of hidden node and output node ^{Tli} , the expectation output the output node ^{tl}

The important steps in BP algorithm

a) Begin

b) Network Initiation

c) Initialize learning sample

d) Compute network layer out of

Each neuro neuron.

e) Compute the train error

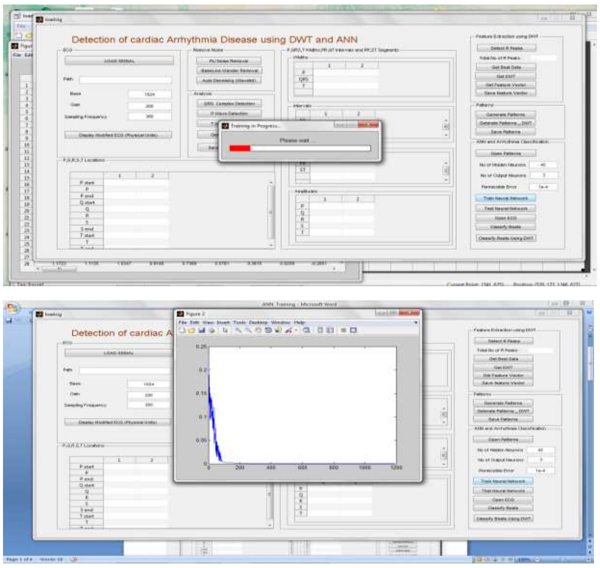
f) Modify the network weight

g) Meet the error precision=.0001

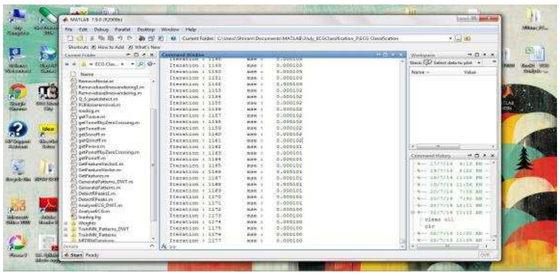
h) End of process

The architecture of the proposed ANN contains thirty inputs neurons, one hidden layer with approximately 2/3 of input neurons plus three output neurons (Approximately 23 Neurons) and three output neurons. The training of the artificial neural network ends if the sum of the square errors for all segments is less than or equal to 0.0001. The number of data set used for training and testing of the ANNs classifier and the results obtained are tabulated in Table. The parameters extracted by DWT based feature vectors of R wave are used as inputs vector to ANNs classification.

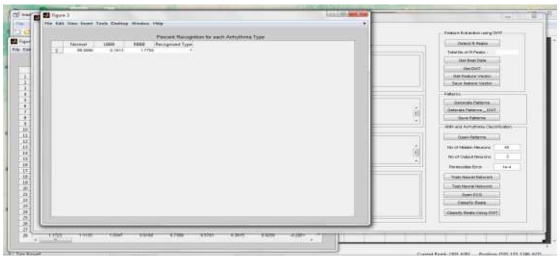
. ***Testing of Feed forward Back Propagation Neural Network***



ANN Training.



Number of Iteration Required To Get 1 E-4



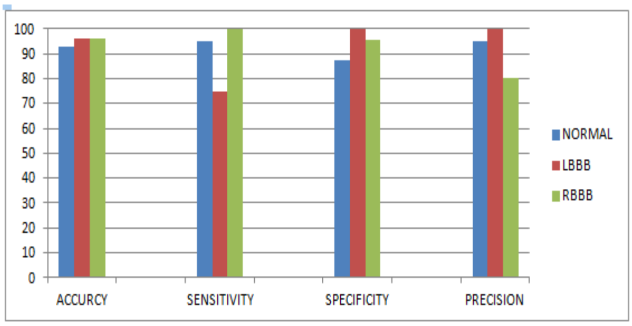
Testing Of Neural Network for Record No. 1

The Testing phase will be used to determine how likely level of success and error recognition of this ANN. The network process consists of feed forward step, which will provide a direct output of data in the form of predictive learning and non-learning are included testing phase. Also just run the feed forward of testing data using the weights from the previous training process.

V. RESULT ANALYSIS

The MIT-BIH arrhythmia database is used to evaluate the proposed algorithm. The performances of the classification are expressed in terms of accuracy (Acc), sensitivity (Sen.), specificity (Spe), Precision (Pre) and overall performance (OP). Their respective definitions using true positive (TP), true negative (TN), false positive (FP), and false negative (FN), all of which can be obtained from the classification results, are as follows

	Accuracy	**Sensitivity**	**Specificity**	**Precision**
Normal	92.59	94.73	87.5	94.73
LBBB	96.29	75	100	100
RBBB	96.29	100	95.65	80



VI. CONCLUSION:-

Analysis of the results listed in Table- shows that effective classification of cardiac arrhythmia accuracy of 92.59 %.for Normal and 96.29% for LBBB and RBBB cardiac disease. The accuracy of the tools depends on several factors, such as the size of database and the quality of the training set and, the parameters chosen to represent the input vector of the classifier. The results conclude that it is possible to classify the cardiac arrhythmia with the help of neural networks. The advantage of the ANNs classifier is its simplicity and ease of implementation.

The accuracy could be improved with increasing the number of training data. The system can be enhanced by detecting sudden cardiac diseases. Furthermore, it is relevant to highlight that new arrhythmias can be added to the proposed system.

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