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Automatic Detection of Heart Disease Using Discreet Wavelet Transform and Artificial Neural Network

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Abstract— ECG plays an important role for analysis and diagnosis of heart disease. ECG signals are affected by different noises. These noises can be removed by de noise the ECG signal. After de noising ECG signals, a pure ECG signal is used to detect ECG parameters. Then Feature extraction of ECG signal is carried out by DWT techniques which are 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 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 given at the end.
Keywords- *ECG, DWT, ANN, RBBB, LBBB.*

I. INTRODUCTION

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 and become one of the most important tools in the diagnosis of heart diseases. The performance of ECG pattern classification strongly depends features extraction from the ECG data and the design of the ANN classifier. The paper describes preprocessing of ECG signal Feature extraction of ECG signal and Classification of ECG signal. In the pre-processing, step first raw ECG signals are converted in to its physical units then noise and interference is removed wave let technique called as preprocessed ECG signal. For Feature extraction, the FV (DWT -Coefficients) are detected. 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, LBBB, RBBB with normal ECG signal. The classification is done by taking FV (DWT coefficients) The MIT-BIH arrhythmias Database has been used for training and testing our neural network based classifier. The simulation results shown at the end for normal and two arrhythmias.

II. PRE-PROCESSING OF ECG SIGNAL

MIT/BIH ECG arrhythmia database used for processing and training performance evaluation of proposed ECG classifier. The pre processing stage removes noise from ECG signal. The ECG signal mainly contains Power line Interference, Electrode contact noise, Muscle noise, Noise due to movement of electrode, Base line drift, Internal amplifier noise and Electromagnetic interference. This can affect the extraction of the ECG parameters. Hence preprocessing is very important step to get noise free signal. The Discreet Wavelet transform is an effective tool for analysis of ECG signals which allows separation of relevant ECG waveform from noise, interface, and base line drift and amplitude variation of the original signal.

In order to remove noise from the ECG signal. The steps in the pre processing process are

a) Display of raw ECG signal to its physical units.
b) Removing baseline drift.
c) De noising of ECG signal.
d) Collection of Pre processed ECG signal.

III. FEATURE EXTRACTIO OF ECG SIGNAL

In feature extraction of ECG signal, first R peaks are detected to detect. Approximately 150 samples are selected after R 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 ANN to classify cardiac arrhythmia.

A. Detection of R peaks and sample selection by using DWT Sample selection

The process starts by segmenting the entire database. Normally, the first step in segmentation is the cardiac peaks detection. However, 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.

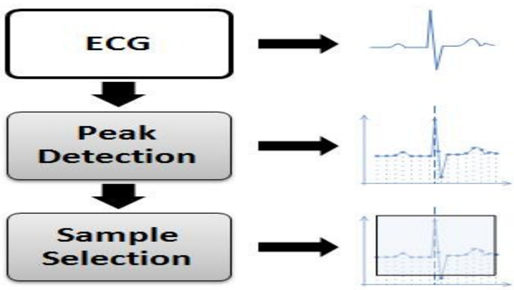


Figure 1. Segmentation of ECG data

The samples selected are submitted to a Wavelet transform, consisting in the 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.

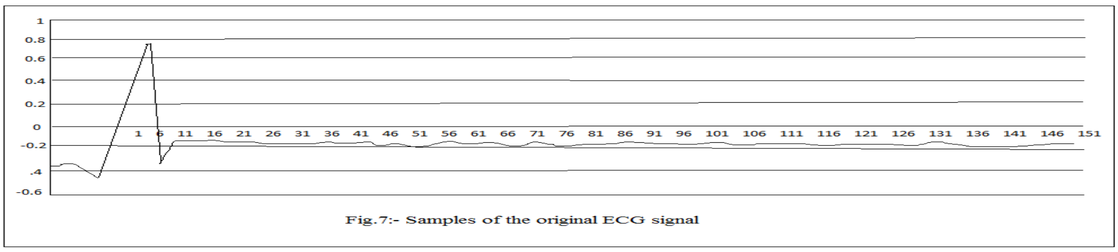


Figure 2. Samples of the original ECG signal

B. Algorithm to get Feature Vector (FV) of ECG Signal using DWT Method.

Input: Denoised ECG Signal (S1), R Peak locations
(Rloc), Wavelet type=db1, Decomposition level=1;
Output: Feature Vector (FV).
Begin,

Step 1 Get Denoised ECG Signal (S1);
Step 2 Get R peak locatiobs (Rloc);
Step 3 Select 150 samples after each R peak,
for i=1:length(Rloc)
SV (i, :) =S1(R (i): Rloc (i) + 150-1) ;
Step 4 Compute DWT to get FV,
[cA, cD]= dwt (SV (i, :),' db1');
Step 5 Get Feature Vector (FV);
FV=cA;
Step 6 save FV.

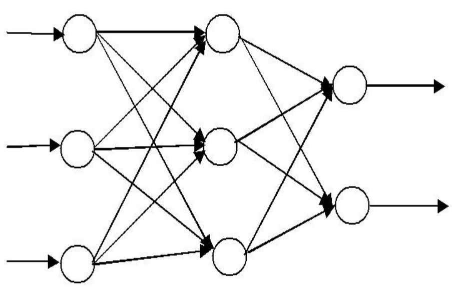
C. ECG pattern Generation

The paper represents three different types of ECG signals are statistically classified as NORMAL, LBBB, and RBBB. 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. CLASSIFICATION OF ECG BY ANN

Artificial Neural Network is biologically inspired network that are suitable for classification of biomedical data. A combination of wavelets transform 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 x_j , hidden node y_i , output node j , network weight of input node w_{ig} , network weight of hidden node and output node T_{li} , the expectation output the output node t_l , Figure 1 shows the BP neural network structure.



Input Layer Hidden Layer Output Layer

Figure 3. Artificial Neural Networks

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 (Method-1 PQRST segments, intervals and amplitude and for Method -2 DWT based feature vectors of R wave) are used as inputs vector to ANNs classification.

A. Testing of Feed forward Back Propagation Neural Network

This 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.

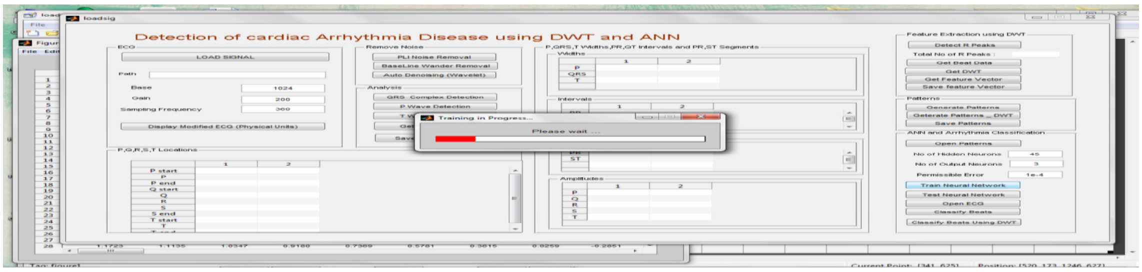


Figure 4. ANN Training.

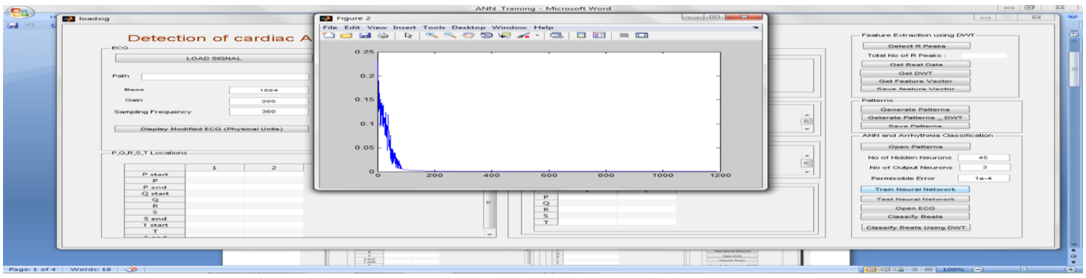


Figure 5. Number of Iteration Required To Get 1 E-4

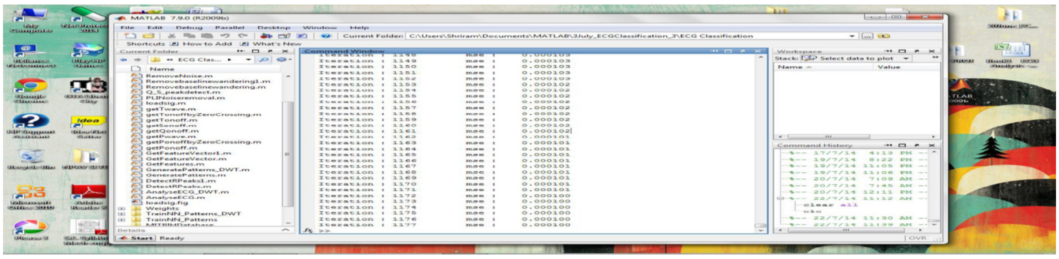


Figure 6. Number of Iteration Required To Get 1 E-4

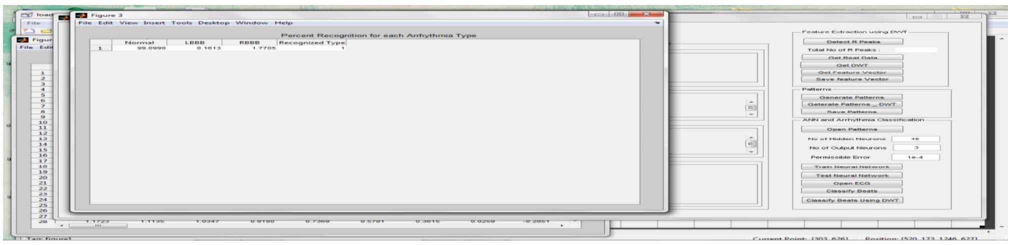


Figure 7. Testing Of Neural Network for Record No. 100

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.

Table 1. Classification results

	ACCURACY	SENSITIVITY	SPECIFICITY	PRECISION
NORMAL	70.37	63.15	87.5	92.3
LBBB	85.18	75	86.95	50
RBBB	74.07	50	78.26	28.57

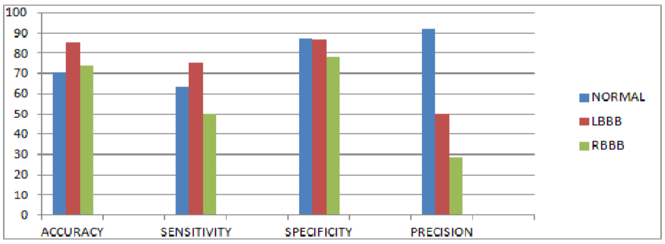


Figure 8.Graph

VI. CONCLUSION

Analysis of the results listed in Table- shows that effective classification of cardiac arrhythmia with an overall accuracy of 95.06%. 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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