Volume: 6 **Issue:** III **Month of publication:** March 2018

DOI: http://doi.org/10.22214/ijraset.2018.3599

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

ECG Classification Using Learning Vector Quantization

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Abstract: ECG signals yield critical information about the electrical activity of the cardiovascular system. It has very important role in the primary diagnosis of diseases and heart related abnormalities. This paper presents the classification and analysis of ECG signals using wavelet decomposition technique and neural networks. We use the learning vector quantization technique to train our neural networks.
Keywords: Electrocardiogram, wavelet decomposition, neural networks, learning vector quantisation

I. INTRODUCTION

Electro cardiogram is of significance for analysis and observation of human body. ECG waveform is composed of P wave, QRS complex, and T wave. The shape, duration, and relationship of P, QRS complex, and T waves components and R-R interval are critical parameters in the identification of heart diseases.

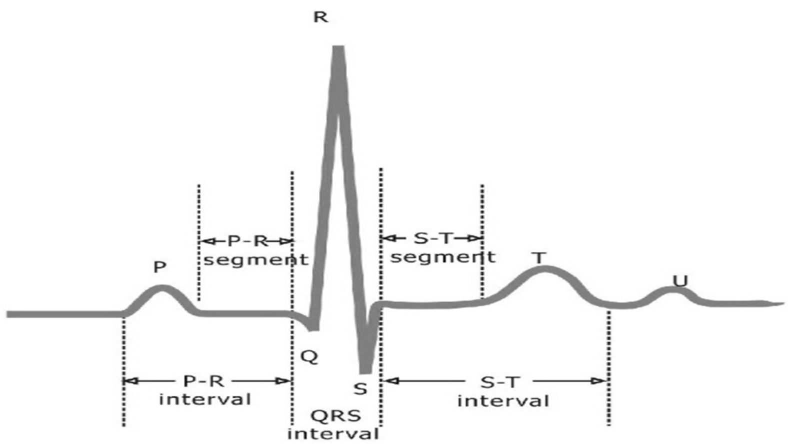

Fig 1. ECG Signal

Artificial neural networks categorize the data from the features extracted out of the ECG signals. They are described by its nonlinearity which enhances its ability on managing non-linear problems and provides great resilience to noise and disturbance.

II. METHODOLGY

The processed signals utilized as a part of this paper are extracted from the MIT-BIH database. When an ECG signal is recorded numerous types of noises are likewise recorded along because of high and low

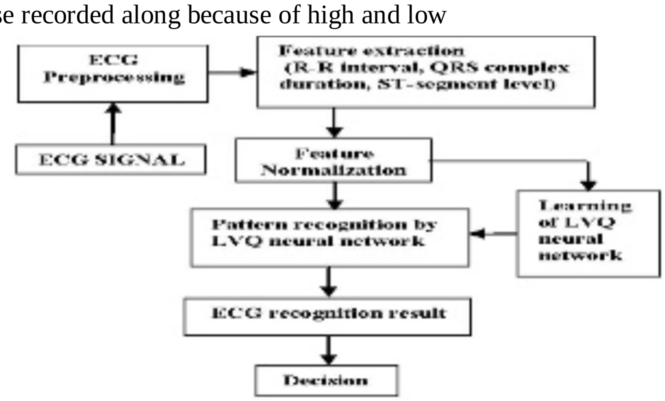

Fig 2. Block representation of classifier

Frequencies, making an ECG have baseline drift and noise. As a result, it becomes exceptionally difficult for analysis. For a thorough determination of ECG it is important to eliminate noises from the signal. After the signal is pre-processed, further processing can be performed. We used wavelet decomposition technique for extraction of feature of the signals. The Wavelet transform is a source for analysing signals of varying frequencies. The transform applied here can express signals in various resolutions by dilating and compressing its basis functions. DWT-based feature extraction technique bears better results. The initial step includes pre-processing of ECG by filtering unwanted high frequency noise in ECG signals. The pre-processed signals were transformed into time-frequency representations using DWT (Discrete Wavelet Transform). The primary benefit of this transform is better time resolution and great time and frequency localization ability. As a result, the DWT exhibits the local features of the input signal. Thus the position and peak values of R, P, Q, S and T are acquired.

A. ECG Feature Detection Procedure

Down sampling of the signal was executed using wavelet decomposition. Thus the samples are taken at a much lower frequency than the original signal. Therefore, it preserves the QRS complex by reducing the details.

The coefficients are obtained and the frequency ranges are isolated. As appeared in figure 3, first signal is similar to the real signal but has precisely one fourth of samples in comparison to the original signal as it was disintegrated in 4 levels. Second level has precisely half the number of samples that of first level, third level has precisely half number of samples than second level.

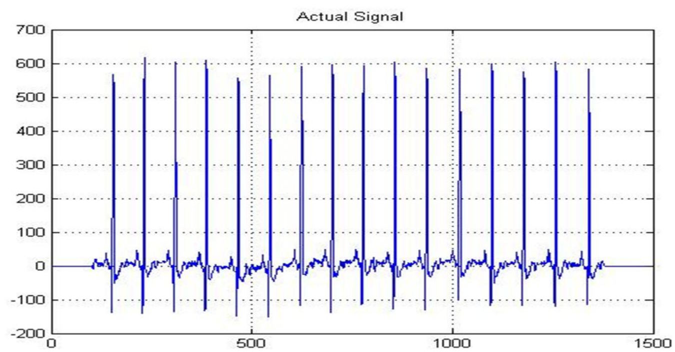

Fig 3. Actual Signal

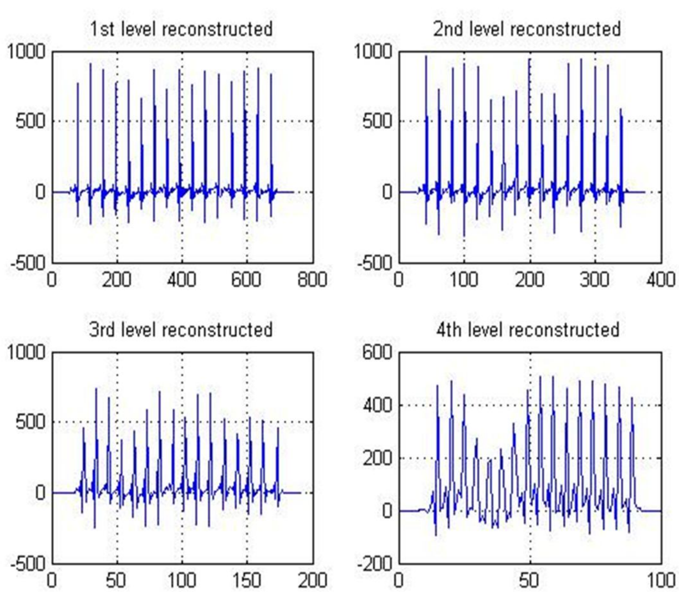

Fig 4. Reconstructed signal

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B. R Peak Detection

R waves have the largest peak value. To determine the peak value in the original signal, initially it is identified in the Noise free signal. After which those values are cross checked with the original signal. Recognition of R peaks is critical in light of the fact that they characterize the cardiovascular beats and the precision of every forth coming detection is subject to this.

C. Q And S Peak Detection

The remaining approximation signal was searched for the minimum peak value on both sides of the previously detected R peak. The left least point from R peak indicated Q peak. The right least point represented S peak.

D. P And T Peak Detection

To determine the P and T peak of the ECG performed, the maximum of the signal prior to the Q peak and after the S peak were searched. The maximums of signal when the zero intersections about every R peak which are previously recognized, signify P and T peaks. The maximum of the signals before the zero intersection is the P wave and the maximum value of the signal after the zero intersection is the T wave.

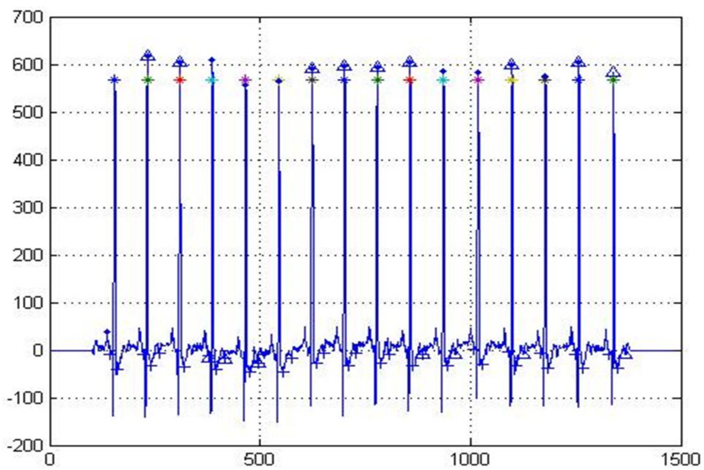

Fig 5. Peaks detected

E. R-R interval detection

By taking the distance between two consecutive R peak, R-R interval is acquired. Mean of the R-R intervals is taken for every ECG signal for categorization of signals into various classes.

F. Learning Vector Quantization

Learning vector quantization is a pattern classification technique. The first layer is a competitive layer and the second layer is the linear layer. As in a self-organising map, the first layer, that is the competitive layer learns to classify the inputs. The classes of the competitive layer are converted into target classifications by the linear layer based on user's definition. The classes learned by the competitive layer are called subclasses and classes of the linear layer as target classes. In our case, we take the average of R-R intervals and train our network to group the ECG signal provided as input into two classes normal and abnormal. The data obtained from the feature extraction process was converted in to vector form using MATLAB and this data is fed into our learning algorithm. Based on the provided test value, the neural network comes up with a range of values to classify the input into the specified classes.

III. CONCLUSION

We obtain random ECG signals from MIT BIH Data base for classification and analysis purpose. The obtained signal generally contains noise. Therefore, we use digital signal processing techniques for denoising and Wavelet transform technique for extraction of feature from the input signal. Then the obtained data is fed to neural network to train them for classification into specified categories. The training algorithm used here is learning vector quantisation.

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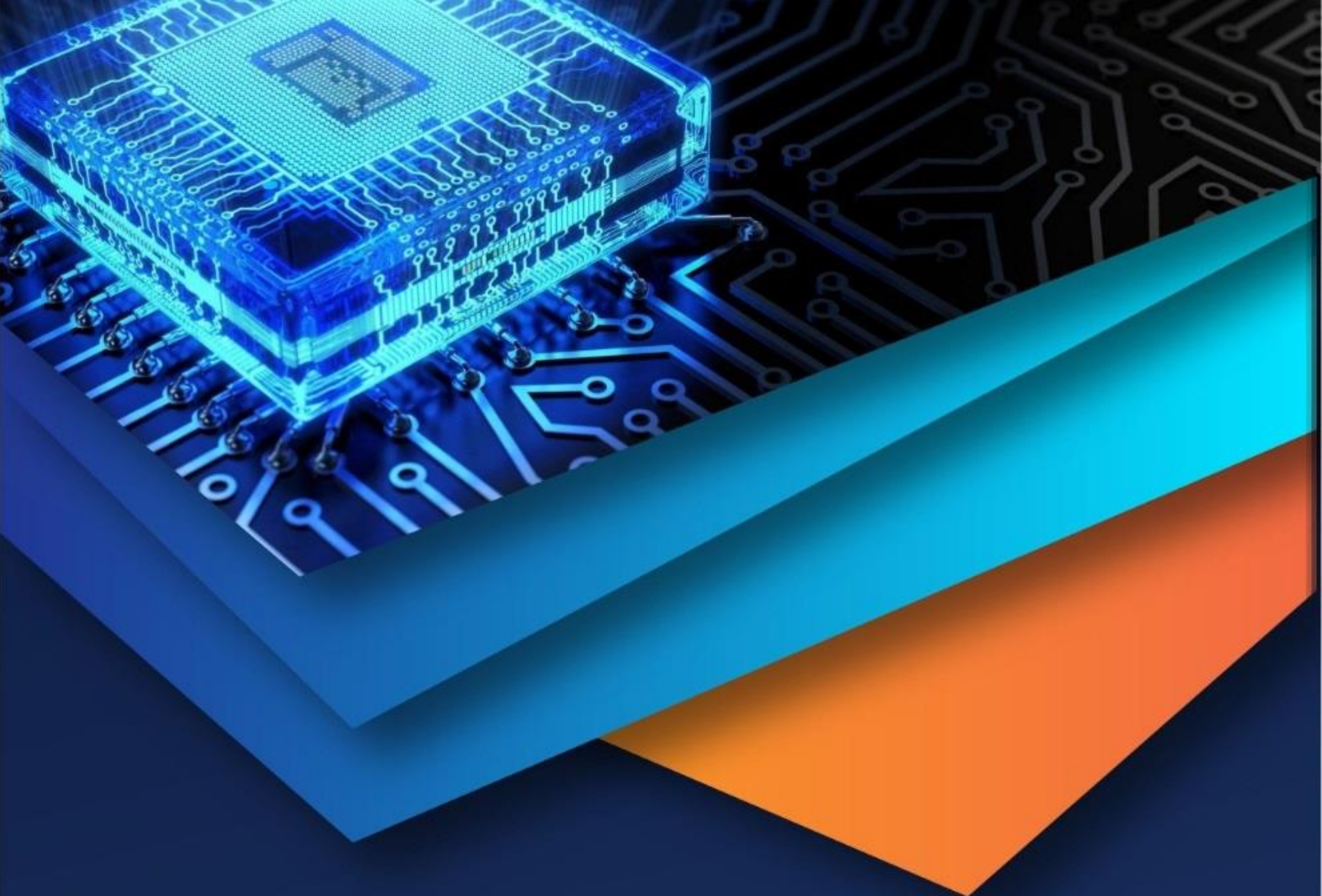

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