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RESEARCH ARTICLE

ANALYSIS OF ECG WAVE USING PERCEPTRON NEURAL NETWORK

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Abstract

Automatic Detection and classification of Cardiac abnormalities and Arrhythmias from a limited number of ECG signals is of considerable importance in critical care or operating room patient monitoring. We propose a method to accurately classify the heartbeat of ECG signals through the Perceptron Neural Networks. Feature sets are based on QRS complex of the ECG signal. The proposed method is capable of distinguishing the normal beat and 6 different arrhythmias. The results of the analysis are found to be more accurate and easily calculated than the other existing methods. Detection and classification of cardiac signals is important for diagnosis of cardiac abnormalities and hence any automated processing of the ECG that assists this process would be of assistance and is the focus of this paper.

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Introduction:-

We use a Perceptron Neural Network based adaptive filter to model the lower frequencies of the ECG which are inherently nonlinear and non-stationary. The residual signal which contains mostly higher frequency QRS complex energy is then passed through a matched filter to detect the location of the QRS complex. We developed an algorithm to adaptively update the matched filter template from the detected QRS complex in the ECG signal itself. The objective in this paper is to study whether using a Perceptron Neural Network based approach will enable us to further improve the performance of the QRS detector. This Perceptron Neural Network based filter is very effective at removing the time-varying, nonlinear noise characteristic of ECG signals.

Each heart beat consists of five parts: P, Q, R, S, T. Each of them has specific meanings. The processing steps required of a state-of-the-art computerized ECG arrhythmia monitoring system are pre-processing, QRS Complex Detection, Beat-by-Beat ECG Signal Classification and Morphology Feature Extraction, On-line Diagnosis.

For reliable ECG monitoring system, a fundamental performance requirement is that it must detect all life-threatening symptoms while not giving too many false alarms. Although off-line ECG signal processing systems have claimed much success, the state-of-the-art on-line monitoring system still leaves much to be desired.

In particular, since the design philosophy is to detect every possible abnormality, the false alarm rate of the current method is still too high.

In this model, the background noise includes the usual instrument noise, muscle noise, as well as the low frequency P and T waves of the ECG signal. Before conventional detection algorithm adaptive matched filter is applied, it is crucial to devise an effective method to remove the background noise so as to improve the signal-to-noise ratio.

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We have some a priori knowledge of the signal of interest such as a typical template of the QRS complex. However, the actual shape of such a template is different for different patients and changes with time in the same patient. Given such prior knowledge, our approach for detecting its presence in an ongoing ECG is based upon a matched filter.

In the signal detection problem, the objective is to detect the presence of a signal in the received signal which is contaminated with additive noise. For ECG beat detection, the signal represents the QRS complex, and the noise represents all other components of the ECG signal including the P and T waves, additive instrumentation noise, and time-varying electromyography noise.

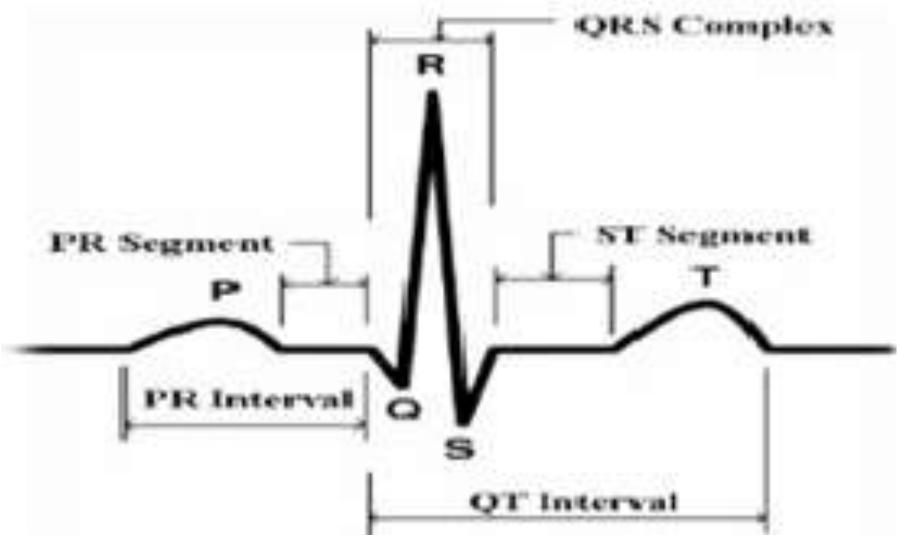

Fig.1:- QRS Complex.

Analysis Method:-

Perceptron are useful as classifiers. They can classify linearly separable input vectors very well. Convergence is guaranteed in a finite number of steps providing the Perceptron can solve the problem. The design of a Perceptron network is constrained completely by the problem to be solved. Perceptron have a single layer of hard-limit neurons. The number of network inputs and the number of neurons in the layer are constrained by the number of inputs and outputs required by the problem. Training time is sensitive to outliers, but outlier input vectors do not stop the network from finding a solution. Single-layer Perceptron can solve problems only when data is linearly separable. This is seldom the case. One solution to this difficulty is to use a preprocessing method that results in linearly separable vectors. Here we use multiple Perceptron in multiple layers. Alternatively, we can also use other kinds of networks such as linear networks or back propagation networks, which can classify nonlinearly separable input vectors.

QRS Complex Detection

Adaptive filtering involves the changing of filter parameters (coefficients) over time, to adapt to changing signal characteristics. Adaptive filters self learn. As the signal into the filter continues, the adaptive filter coefficients adjust themselves to achieve the desired result, such as identifying an unknown filter or cancelling noise in the input signal. In the figure below, the shaded box represents the adaptive filter, comprising the adaptive filter and the adaptive recursive least squares (RLS) algorithm.

An adaptive filter designs itself based on the characteristics of the input signal to the filter and a signal that represents the desired behaviour of the filter on its input.

Designing the filter does not require any other frequency response information or specification to define the self-learning process the filter uses; we select the adaptive algorithm used to reduce the error between the output signal and the desired signal.

When the LMS performance criterion for error has achieved its minimum value through the iterations of the adapting algorithm, the adaptive filter is finished and its coefficients have converged to a solution. Now the output from the adaptive filter matches closely the desired signal. When you change the input data characteristics, sometimes called the filter environment, the filter adapts to the new environment by generating a new set of coefficients for the new data.

After passing through the band pass filter the signal may be squared and averaged over a number of samples to give an estimate of the local energy in the pass band which is then used as a detection statistic. These techniques mainly suffer from two problems:

1) The signal pass band of the QRS complex is different for different subjects and even for different beats of the same subject

2) The noise and QRS complex pass bands overlap. A matched filter can maximize the signal to- noise ratio for detection of a known signal in noise. However, the design of an optimal matched filter requires knowledge of both the signal and the correlation statistics of the noise. The non-stationary nature of the signal and noise in an ECG represents an obstacle in application of matched filtering to QRS detection.

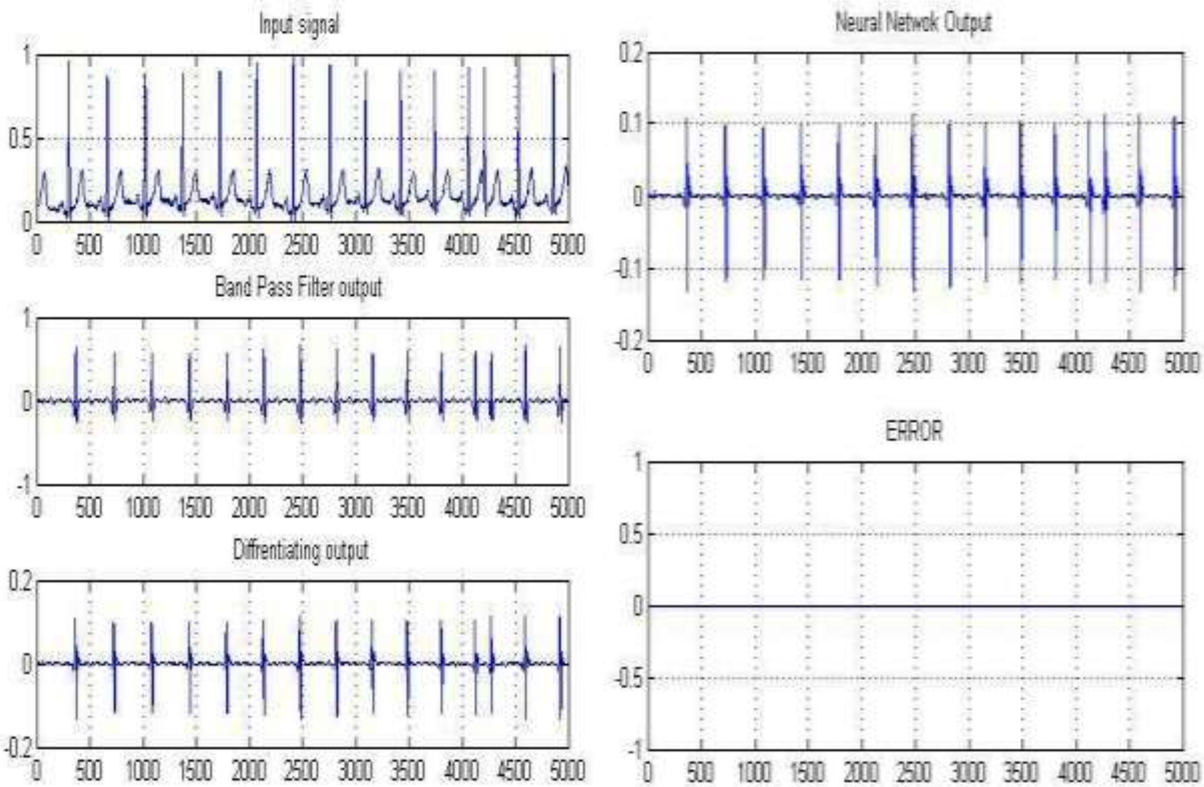

Fig.2:- (a).Input ECG is filtered by BPF and differentiated output. **Fig. 2:-** (b).Neural Network Output compared with filtered output which gives ZERO error.

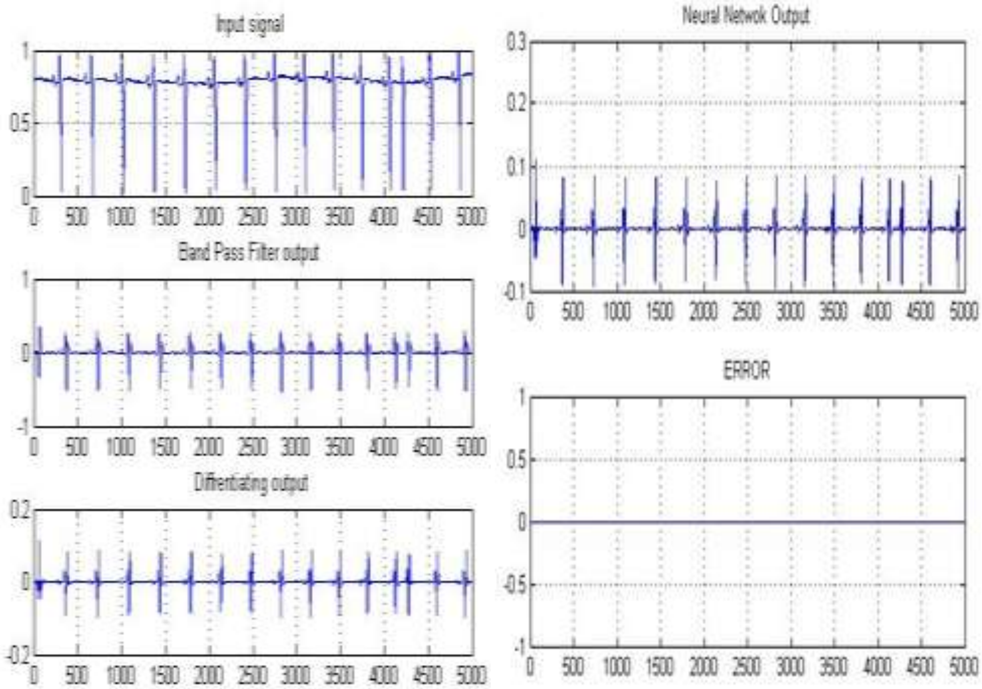

Fig.3:- (a).Input ECG is filtered by BPF and differentiated output. **Fig.3:-** (b).Neural Network Output compared with filtered output which gives ZERO error.

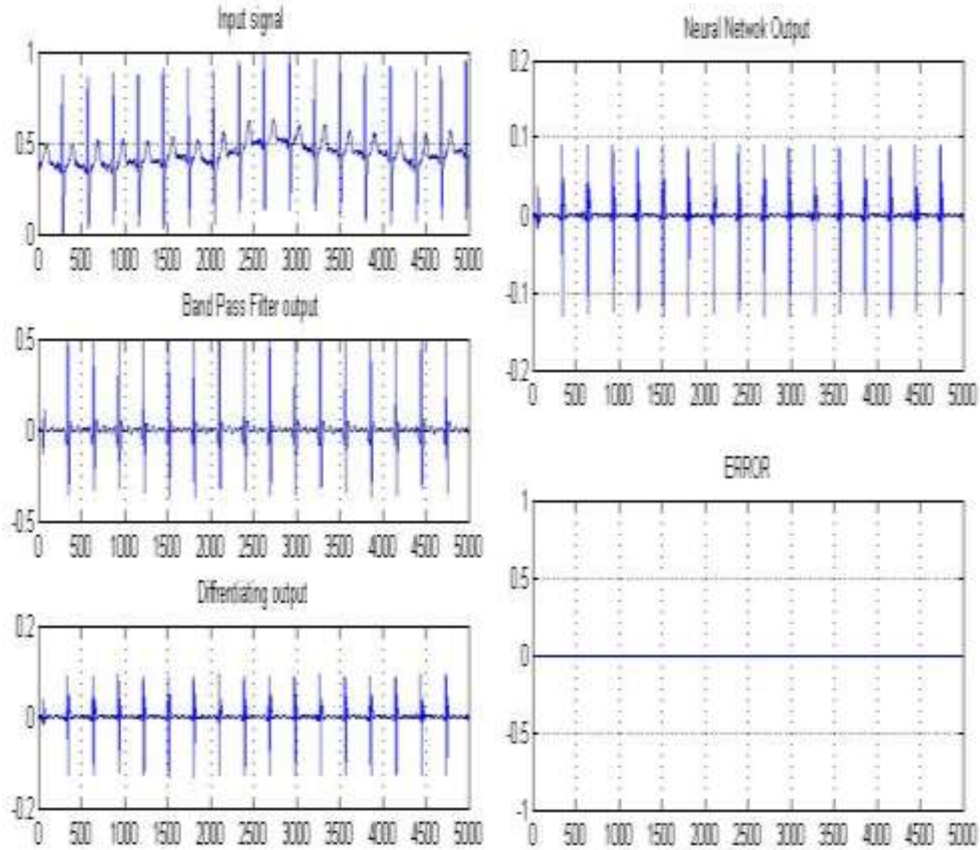

Fig.4:- (a).Input ECG is filtered by BPF and differentiated output. **Fig.4:-** (b).Neural Network Output compared with filtered output which gives ZERO error.

Results:-

The results obtained with the proposed Neural Network using different ECG noise levels. The algorithm based on Neural Network for the detection of QRS complex of ECG signal. It can be notice that good results obtained with the BPF are caused by the resemblance that exists between this Neural Network and the actual ECG signal.

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