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INTELLIGENT ECG SIGNAL NOISE REMOVAL WITH MOVING MEDIAN FILTER USING NEURAL NETWORK

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ABSTRACT

In this paper, the electrocardiogram (ECG) signal is vulnerable to noise and artifacts, it is essential to noise removing using neural network, the noise in order to support First 3600 of noisy heart signals are collected from MIT-BIH data base. In this paper the use of moving median filter & artificial neural network. The available filter for power line interference need a reference channel or regard the frequency is fixed 50/60Hz.

In this literature of the last twenty five years several solution of noise removal on electrocardiogram (ECG) signal can be found. The spectrum of the ECG signal is extracted from the two databases arrhythmia and supraventricular. Baseline wander is removal using the moving median filter. The results shows that the intelligent artificial neural network system successfully denoised ECG signal. This study mainly focuses on cutoff frequency calculating best performance MSE.

KEYWORDS: Finite Impulse Response (FIR), Low–Pass Filter, Artificial Neural Network, Cutoff Frequency, Average Median Filter

INTRODUCTION

The Dutch physician willem Einthoven is marked in 1903 the beginning of a new era in medical diagnostic techniques for Establishment of the clinical electrocardiograph (ECG). Include the entry of electronics in the health care. The ECG is a tool that records and measure the electrical activity of the heart in exquisite detail [3,16].

The function of the pumping blood of heart performs through the circulatory system. The result of mechanical events within the heart is generation of a certain sequence of electrical event. The ECG signal waveform consists of the P wave, QRS wave and T wave, as sketched in figure 1.

The baseline voltage of the ECG signal is known as the isoelectric line and its measure portion of the tracing and following the P wave and preceeding the next T wave. The electrical activity of the heart is generally used by monitoring electrodes placed on the skin surface.

The electrical signal is (normally 0.0001 to 0.003 volt).These signal are within the frequency range 0.05 to 100 Hz. Although there are many new methods for noise removal, the intelligent methods commonly applied include artificial neural network (ANN), support moving median filter. Note that the totals include two types of non-beats for these few records in which they occur.

The total ECG interval of each record is 30 min. and 5.557 seconds. Heart rates are given in beats per minute measured over three R-R intervals [4], shown in figure 1. The next designated cut-off frequency development of FIR window function for reduction of baseline drift in the ECG signals [2].

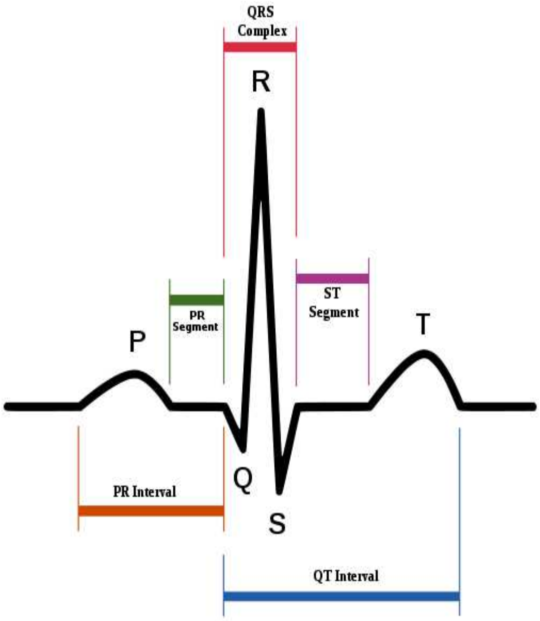

Figure 1: ECG Signal Wave Form

Nowadays ECG signal noise removal has been discussed in many research works [6-11-12], independent component Analysis is used for analysis to remove noise from ECG recordings and reconstructed ECG signal were compared with original signal and effectively reconfigured noise reduction filter by neural network and genetic algorithm. Neural network based control module effectively select moving median filter .Sara Moein [1] et al. Designed and applied a FIR filter to the ECG signal containing power line noise. Complete design is performed with FDA tool in the MATLAB [9]. The FIR Kaiser Window filter designed is having low pass due to which increase in the computational complexity observed. Previous studies have showed that the neural network based method present effective approaches for denoising ECG signal. There are also some algorithms for moving median filter of the ANN itself. There is insufficient research in the area of automated calculation of cut-off frequencies. This paper presents application of ANN to identify the cut-off frequency for removal of the high frequency noise in ECG signal using a FIR filter [2].

METHODOLOGY

In this paper the electrocardiogram (ECG) signal is susceptible to noise and artifact and it is essential to noise removing using neural network ,the noise to support First 3600 of noisy heart signal are collected from MIT-BIH data base. The use of moving median filter & artificial neural network for power line interference need a reference channel or regard as shows figure 2 & 3. In this literature of the last 20 five years several solutions of noise removal on electrocardiogram (ECG) signal can be found. The spectrum of the ECG signal is extracted from the two classes: arrhythmia and supraventricular. all 3600 signal must be transformed to frequency domain using Fast Fourier Transform(FFT) [8,13,17]. Figure 2 & figure 3.Baseline wander is removal using the average median filter figure 4. A Finite Impulse Response (FIR) filter is capable to remove the noise. A moving median filter smoothes data by replacing each data point with the median of the neighboring data point defined with in the span. The moving median filter takes a subset of those points figure 5; this process of low passes filtering with the response of the smoothing given by the difference equation [7].

$$Y_s(i) = 1/(2N + 1) (Y(I + N) +\ldots\ldots Y(i - N)) \quad (1)$$

Where Ys (i) is the smoothed value for the its data point, N is the number of neighboring data point on either side of Ys (i), and 2N+1 is the span [7], The results show that the intelligent artificial neural network system successfully denoised ECG signal. In this section FIR Equiripple filter windowing FIR filters with Kaiser window.The basic specifications for design of filter are:

- Passband frequency and Stopband frequency is 50 to 60 Hz.
- Sampling frequency 360Hz(MIT/BIT data base sampled at 360 Hz)

The other guidelines are pass-band ripple and stop band ripple. In the design of FIR equiripple design,pass-band ripple is one db,stop-band ripple is 80 db and the minimumm order of the filter. And widow length if of Kaiser window is 451 which is selected according to filter order 450.

$$h(i)=\sin[2\pi(i-p)\, f_1\, T\,] - \sin[2\pi(i-p)f_0] \quad (2)$$

Where h(i) is given by the equation(2) and h(p) is given by equation(3).

$$H(p)=2[f_1 - f_0]T \quad (3)$$

Note that T is the sampling period and is given by equation (4)

$$T = 1/f_s \quad (4)$$

The FIR magnitude plot show that with increasing filter,the sharper the transition band of the filters are besides differing linear phase shifts.It is also noted that with increasing filter order the pass-band ripple decreases and attenuation at the cut-off frequency increases has been shown in table 1.

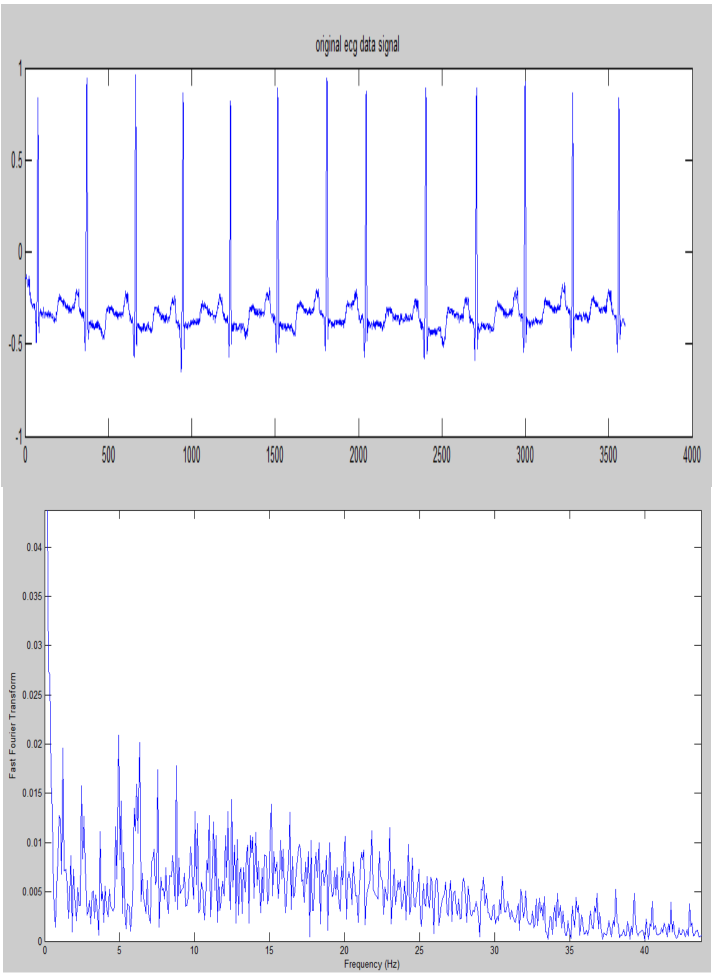

Figure 2: Original Arrhythmia ECG Signal and Frequency Spectrum. of ECG Signal

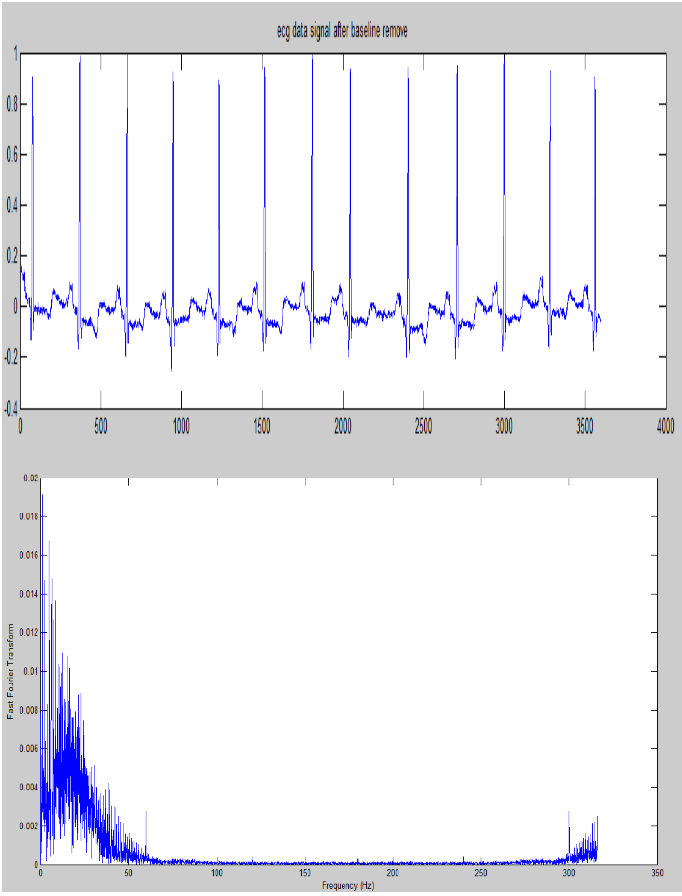

Figure 3: Base Line Arrhythmia ECG Signals and Frequency Spectrum of Base Line ECG Signal

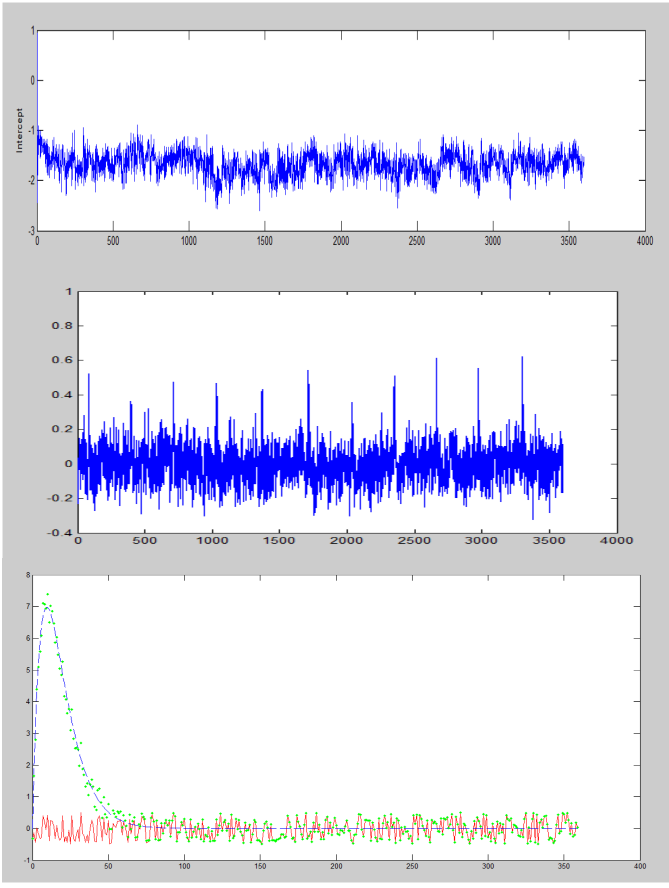

Figure 4: ECG Signal Denoising with Kaiser Window and Moving Median Filter

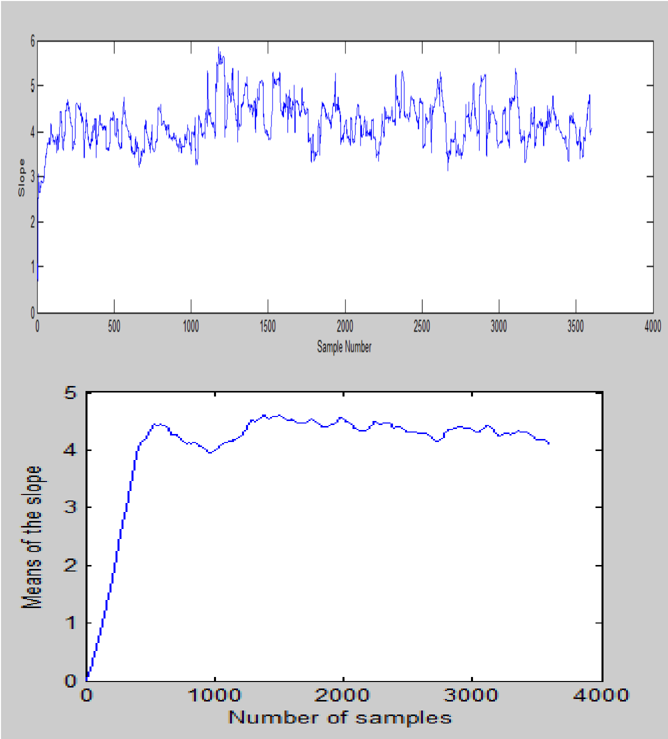

Figure 5: Resulting Baseline Wanders of ECG Signal and Conventional Drift Attenuation

Table 1: (Calculating Cut-Off Frequency for Different ECG Signal)

S. No.	Signal	Mean FFT	Standard Deviation	Variance FFT	ω_c
1	Arrhythmia	0.137	7.3278	53.6968	0.80
2	Arrhythmia	0.03	9.8800	97.6153	0.33
3	Arrhythmia	0.010	22.4077	502.1050	0.60
4	Arrhythmia	0.0075	9.0126	81.2265	0.80
5	Arrhythmia	0.10	15.375	236.30	0.60
6	Superventricular	0.65	6.5571	43.2313	0.33
7	Superventricular	0.08	6.6686	44.4696	0.33
8	Superventricular	0.12	6.0257	36.3094	0.22
9	Superventricular	0.07	7.1342	50.8971	0.60
10	Superventricular	0.0585	6.6206	43.8329	0.60

MSE PERFORMANCE

The mean square error (MSE) measured for varying numbers of hidden nodes and number of training epochs and cutoff frequency figure (6) shows.[14,15] the affect of variable training cycle on MSE is closed to zero.Its shows that the better performance on table 2.

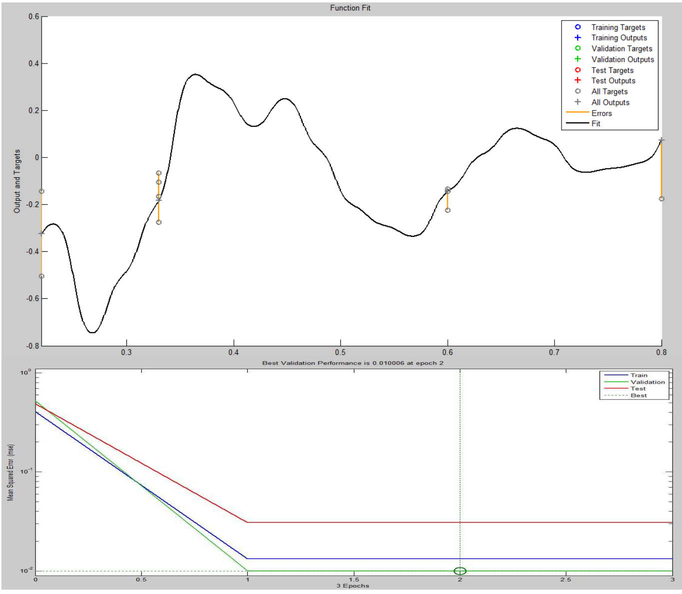

Figure 6: Output and Target and Training Cycle of MSE

Table 2: (Best Validation MIT-BH Signal with MLP)

S. No.	Signal Type	Best Validation
1	Arrhythmia	0.010006
2	Arrhythmia	0.17217
3	Arrhythmia	0.1426
4	Arrhythmia	0.078638
5	Arrhythmia	0.027446
6	Superventricular	0.62989
7	Superventricular	0.094491
8	Superventricular	0.77888
9	Superventricular	0.028922
10	Superventricular	5.0009

CONCLUSIONS

In this paper noise reduced from Different ECG data signal using FIR digital filter and calculate cut off frequency for various 222txt signal and compare these cut off with the help of Artificial Neural Network. After training with Neural Network results shows that best validation for arrhythmia signal is more than other signal and shows the performance more than 90%.which is 0.010006.(arrhythmia signal No.1) Applying recurrent and unsupervised ANN can improve the presented method.

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