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Noise Removal in ECG Signal Using Digital Filters

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Abstract: The Electro Cardio Gram (ECG) is a parametric index to diagnose heart diseases. During the process of acquisition of the ECG signals, it is added up by large amount of noise, which affects the patient diagnosis with respect to telemedicine. The noisy ECG signals have drift in baseline, motion electrodes artefacts, interference of line, muscle contraction noise, etc. Noise reduction is accomplished by making using of adaptive filter which employs wavelet transform. Computer simulation results are shown for the improvement in performance. This methodology adapted successfully removes various types of noise with Signal to noise ratio (SNR). The impact of noise and removal of it are shown in the waveforms and the methodology adopted has produced 82% improvement on the SNR of de-noised signals.

Keyword: ECG, SNR, Filters, De-noise, DSP.

1. INTRODUCTION

In modern days almost the life span of everybody is reduced due the improper diet which is consumed by every individual. This induces heart attack on all average people which is a challenging task to identify at the early stages. For this purpose the ECG signals are used as a preliminary measurement metric to identify any abnormalities present in the functioning of heart in the earlier stage.

The ECG signals are mainly acquired by placing electrodes on the various positions of the chest and the functioning of heart is recorded in the form of pulses and are recorded which have significant peaks namely PQRST to represent the functioning of heart. Under unavoidable circumstances like Covid- 19 people are asked to consult a physician through telemedicine in order to have the diseases diagnosed and get treated immediately. So the ECG signal is very important metric in order to decide the functioning of heart.

During the acquisition process of ECG signal, the electrodes are placed at the predefined places on the chest to record the signals. The interference of electrodes with the body produces noise which affects the received ECG signal. The removal of noise signal in the ECG is done as research by the researchers by adopting many techniques and methodologies.

There are different types of noises namely baseline noise, electrode motion noise and white noise which interferes with ECG signals. The effect of this noise makes the diagnosis difficult.

The usual traditional methods [1,2,3] used for noise reduction are generally filtering bank method, introduction of low pass filter to reduce the noise as the ECG signal is itself a low frequency signal. The resulting output is not that much efficient in suppressing the noise.

2. PROPSED METHOD

Even though the normal traditional methods produce acceptable results the accuracy in elimination of noise is most important as it's very helpful to predict the functioning of heart. The proposed method employs filtering technique which involves Artificial Neural Network and Discrete wavelet transform for noise reduction. The functioning of the proposed methodology is shown in fig. no1 the first step involves decomposition where the signal is passed through a set of filter banks to segregate the high frequency and low frequency coefficients.

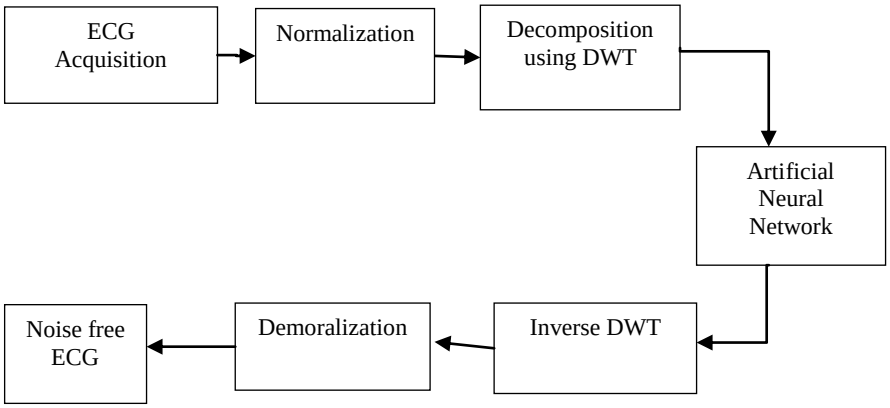

Figure 1 Block Diagram of the Proposed Methodology

In this process the high frequency components are elimated and the low frequency components are used further for processing. The low frequency components are passed through the artificial neural network where its trained with original data set to discrimate the signals as noisy and noise free. The output of the network is de-normalised and it has to reconstruct by taking an Inverse discrete transform for the output obtained and the signal which is noise free is obtained. The proposed methodology holds good for white noise and base line noise. The signal to noise ratio after the filtering process can be calculated using the formula

$$SNR=10\log(S/N) \qquad (1)$$

The values obtained after the filtering process is compared and the results are tabulated in table 1 & 2.

3. RESULTS AND DISCUSSION

The simulated results are shown in figure 2 represents a noise free ECG signal of a person with normal functioning of heart.

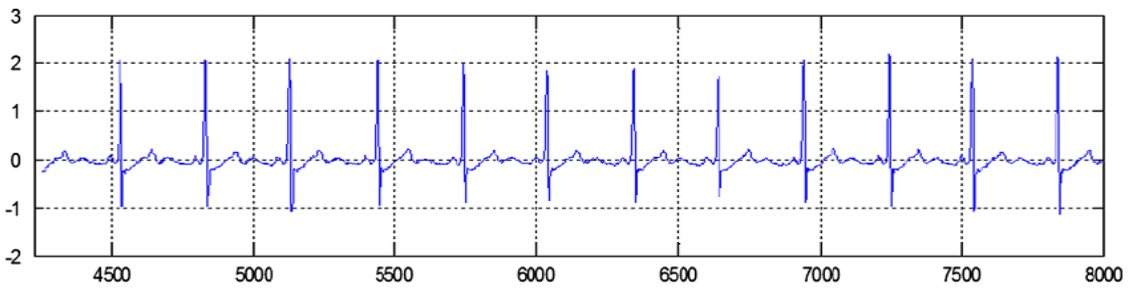

Figure 2 Noise Free ECG Signal

Figure 3 is an ECG signal which has the interference of base wander noise and figure 4 represents the output which is obtained after the execution of the proposed methodology over the noise affected signal.

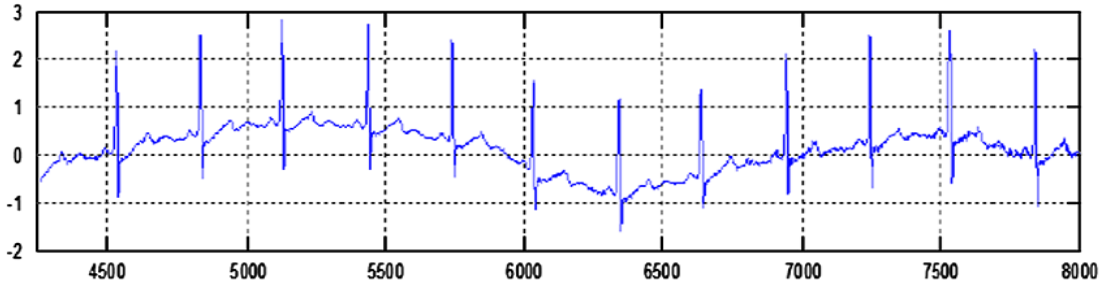

Figure 3 Signal with Base Line Wander Noise

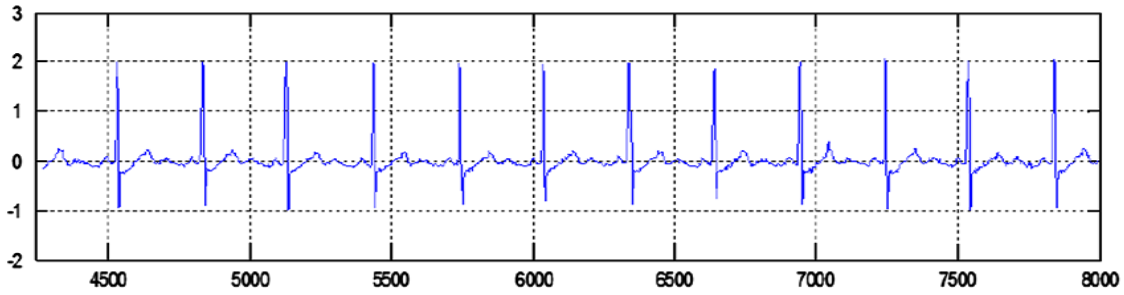

Figure 4 Signal after Filtering of Baseline Wander Noise

Figure 5 is an ECG signal which has the interference of white noise noise and figure 6 represents the output which is obtained after the execution of the proposed methodology over the noise affected signal.

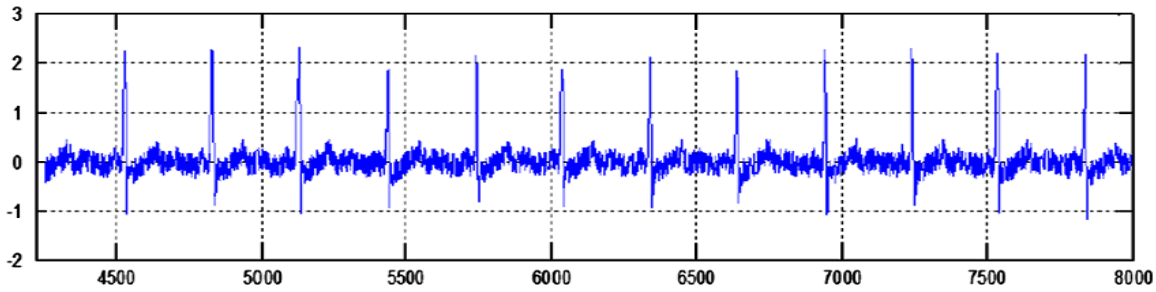

Figure 5 Signal with White Noise

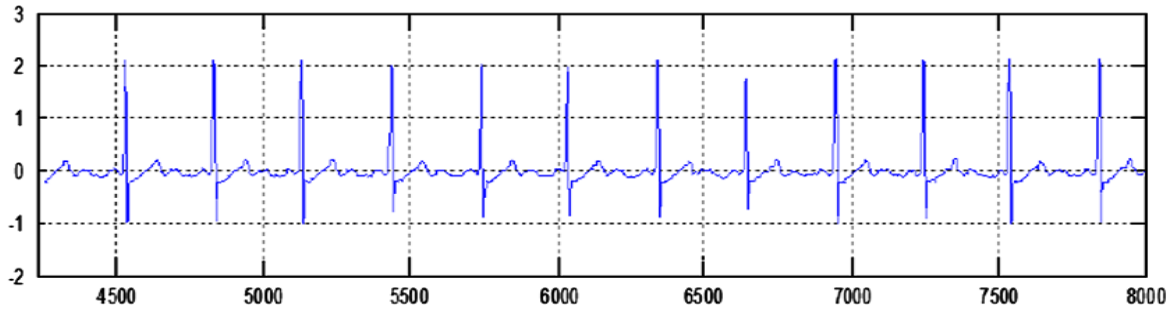

Figure 6 Signal after White Noise Removal

The results are also compared with tradional approaches and the results are tabulated in Table 1 gives the output and its improvement when traditional methods of filtering, DWT is used.

Table 1: SNR after Filtering and its Improvement

Noise	SNR (dB) after filtering	SNR (dB) improvement
Traditional filter groups	17.24	8.52
DWT filtering	11.22	0.5
Proposed approach	30.43	10.72

It also indicates that the proposed methodology implemented produces better result compared to the traditional approaches.

Table 2: SNR & its Improvement for Base Wander Noise

SNR	Noise type	Original ECG	De-noised ECG	Noisy ECG	Improvement
0dB	BW	87.67%	88.02%	85.96%	**82.06%**
1.25dB	BW	84.56%	87.86%	84.59%	**83.27%**
5dB	BW	84.96%	88.61%	87.57%	**81.04%**
Average	-	**85.73%**	**88.16%**	**86.04%**	**82.12%**

Table 2 gives the improvement in SNR when the prised methodology is adapted for base wander noise removal.

4. CONCLUSION

The Filtering concept with Neural networks gives better results in the removal of base wander and white noise compared to other traditional methods. The same technique may be further implemented to poerline noise and motion artefact noise which is generated in the process of acquisition of ECG.

5. REFERENCES

[1] Jilong Wang, Renfa Li, Rui Li,∗, Keqin Li, Haibo Zeng, Guoqi Xie, Li Liu. Model based on adversarial denoising of Electrocardiogram. *Neurocomputing*, (2019).
[2] H. Zang, Z. Wang, Y. Zheng. Analysis of signal de-noising method based on an improved wavelet thresholding, in: *The Ninth International Conference on Electronic Measurement & Instruments*, 2009, pp. I-987–I-990.
[3] Surnai Poungponsri, Xiao-Hua Yu. An adaptive filtering approach for electrocardiogram (ECG) signal noise reduction using neural networks. (2013)
[4] Kunyang Li, Weifeng Pan, Yifan Li, Qing Jiang, Guanzheng Liu. A method to detect sleep apnea based on deep neural network and hidden Markov model using single-lead ECG signal. *Neurocomputing*, 294(2018)94-101.
[5] Yazhao Li, Yanwei Pang, Jian Wang, Xuelong Li. Patient-specific ECG classification by deeper CNN from generic to dedicated. *Neurocomputing*, 2018.
[6] J. Yan, Y. Lu, J. Liu, X. Wu, Y. Xu. Self-adaptive model-based ECG denoising using features extracted by mean shift algorithm, Biomed. *Signal Process Control* 5 (2010) 103–113.
[7] E. Kayalvizhi, N. Sasirekha. A modified low power architecture for Gabor Filter. *Signal Processing* (2016).