Removal of power line interference and baseline wander noise from ECG using FFT/IFFT filter.

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ABSTRACT:

ECG signals obtained for diagnosis normally contain a lot of noises and artifacts such as power line interference, baseline wander noise, high frequency noise and noise generated by human body. These noises degrade signal quality, which may be critical for routine monitoring and diagnosis. Primarily the power line interference and baseline wander noise affect the ECG signal strongly. In this paper a fast Fourier transform/ inverse fast Fourier transform (FFT/IFFT) filter is used to reduce power line interference and baseline wander noise in ECG signal.

KEYWORDS: Power line interference, Baseline wandering, FFT, IFFT

INTRODUCTION:

Electro Cardiogram (ECG) is a graphical recording of electrical impulses generated by heart. ECG signals are mostly affected by white noise, colored noise, electrode movement noise, muscle artifact noise, baseline wander, composite noise and power line interference. These noise and interference makes the incorrect diagnosis of the ECG signal. In this paper we are focusing on two noises which cause the ECG graph to obscure. These noises are power line interference and baseline wander noise.

The human body absorbs electromagnetic radiation from power lines and this is associated with noise signals that contain a 50 Hz sinusoid and its harmonics. Human body motion causes baseline wandering in the recorded ECG signal. Its frequency band is much lower than the band of the ECG signal which normally is in the range 0.5-40 Hz in monitoring. It is difficult to work on the signal in time domain. So, the proposed method used in this paper is to convert time domain ECG signal into frequency domain signal and then filter out the noises in it using Discrete Fourier transform. FFT is a Fast Fourier transform technique used for Discrete Fourier transform. So, basically reason behind using FFT/IFFT filter is to get reduced power line interference as well as baseline wander noise at a time. As, the frequency of both these noise is different the filter have to be work on two different cut-off frequencies. So, this filter can also be called as reconfigurable filter.

LITERATURE REVIEW:

In the literature, several methods were proposed to remove a single noise component from ECG signals. In reference [1] the filter used is same i.e. FFT/IFFT filter but the input ECG signal is obtained from the patient directly and for obtaining it a holter is designed. This holter contains the analog to digital convertor, microprocessor and the FPGA. But every time getting a patient for ECG and obtaining ECG is difficult and that's why in this paper an ECG signal is taken from the MIT-BIH database which is a digital signal. In reference [2] a new two-stage algorithm for electrocardiographic (ECG) signal de-noising has been proposed. It combines wavelet Shrinkage with Wiener

filtering in translation-invariant wavelet domain. The de-noising approach is to decompose the signal noise mixture in transform domain, where a small number of significant Coefficients represent the signal features while the rest big number of small value coefficient are insignificant. As the noise is spread over all transform coefficients the small ones are harder influenced by it. Disregarding the coefficients below a predetermined threshold one can obtain noise-free signal estimation by inverse transform.

Many literatures give the ECG signal enhancement techniques using adaptive filters only the algorithm of adaptive filter changes. Likewise in reference [3] the least mean square algorithm is used as an adaptive algorithm but it is improvise by using it as block least mean square algorithm and then FFT technique is used in it. So, it becomes FBLMS algorithm. This algorithm has less computational complexity and good filtering capability. The FBLMS algorithm, being the solution of the steepest descent algorithm for minimizing the mean squared error in a complete signal occurrence, is shown to be steady-state unbiased and with a lower variance than the LMS algorithm. The performance of the FBLMS algorithm is superior than the LMS algorithm.

In reference [4] the adaptive filter is used for removing the noise in the ECG. In this literature two algorithms are used for noise reduction. Least Mean Square algorithm and Normalized Least Mean Square algorithm. In this technique the noise is added in the signal and the processed signal is then added with the signal which is noise contaminated. But in this method NLMS algorithm gives better result than LMS algorithm. A method for ECG de-noising based on Wavelet Shrinkage approach using Time-Frequency Dependent Threshold (TFDT) has been given in reference [5]. The TFDT is high for the non-informative wavelet coefficients, and low for the informative coefficients representing the important signal features. In this literature the de-noising is improved by involving Empirical Wiener Filtering in Wavelet Domain using the TFDT for calculation of the "pilot signal estimation. Here two-stage algorithm is used for achieving the de-noising. But in this method decomposing of the basic functions is very important and this can be improved by the transform domain coefficients.

PROPOSED METHOD:

The method we are going to use in this paper is to use fast Fourier transform filter to filter out the power line interference and baseline wander noise in the ECG signal. As, we have to convert the time domain signal into frequency domain. The input ECG signal is taken from the MIT-BIH database which gives the ECG signal that can be converted into frequency domain. The proposed block diagram is shown below,

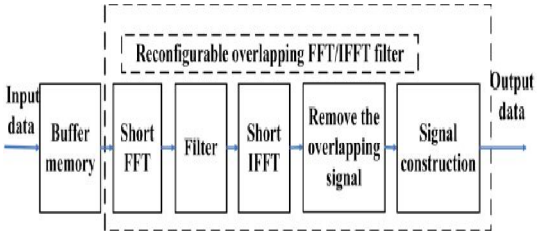

Figure 1. Block diagram of proposed method.

As shown in figure the signal from MIT-BIH database can be applied as input to the buffer memory block. The buffer memory block is used for the purpose of storing the signal. The buffer memory block is designed in the active HDL software. Then for converting the signal in frequency domain it is applied to the short FFT block. It is very difficult to take FFT of larger order. So, in this case we are using pipelined FFT which will give us the right results with less computation than the conventional FFT method. After converting signal in frequency domain it will be applied to filter to filter out the noise i.e. the power line interference and the baseline wandering in the ECG signal. The filter should be able to remove the noise in ECG signal. So, filter has to work on the different cut-off frequencies as the frequency of power line interference and baseline wander noise is different. This filter can be called as reconfigurable filter as it will work for different cut-off frequency. After removing the noise from the signal we have to again convert the signal in time domain and for that purpose it is applied to the short IFFT block. This block will perform Inverse Fast Fourier transform on the filter out signal and convert it back to time domain. As, for diagnosis the signal should be in time domain not in frequency spectrum. But when the power line interference is removed from the ECG signal some of the ECG signal also gets

cancelled as the frequency of power line interference as well as the ECG signal is 50Hz. To avoid this a mechanism is used to remove the overlapping of the signal which will give the ECG signal without overlapping. All these operations given above are performed on the samples of ECG signal at the final stage the signal is reconstructed i.e. assembled. This total filter can be called as reconfigurable overlapping FFT/IFFT filter. These all blocks in above figure are desined in active HDL and then dumped to the FPGA.

CONCLUSION:

In this paper a filter is designed for removing the power line interference and the baseline wander noise from the ECG signal. The FFT/IFFT filter is used to enhance the ECG. The techniques used in reference [2], [3] only one noise can be removed at a time. But as we are using reconfigurable filter the power line interference as well as the baseline wander noise both are removed from the ECG signal by using the proposed method. In reference [2] a two-stage procedure for ECG de-noising is used in which the Wiener filtering and translation-invariant wavelet transform is taken for removing noise. While in reference [3] the proposed method used a Fast Block LMS (FBLMS) algorithm which gives better SNR than LMS algorithm. Also in reference [4] both LMS and NLMS algorithms are used but NLMS gives better result than LMS algorithm. In this paper our proposed method is using FFT\IFFT filter as we have seen in references [2],[3],[4],[5] it is difficult to work on ECG signal for removal of noise. So, in this method we will work in frequency domain and converting back signal in time domain after processing. This proposed method is simpler to implement.

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