Elimination of Power Line Interference in ECG Signal Using Adaptive Filter, Notch Filter and Discrete Wavelet Transform Techniques

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ABSTRACT
An ECG is a biomedical non-stationary signal, which contains valuable information about the electrical activity of the heart. The ECG is very sensitive and a weak signal, hence, it gets corrupted by various types of noise such as power line interference, baseline wander, motion artifacts, muscle contractions, electrode contact noise, etc., that may lead to a misdiagnosis. Among these noise parameters the power line interference is very crucial because noise falls in the ECG bandwidth, i.e. 0.05 Hz to 100 Hz. The article proposes the removal of power line interference (PLI) noise in an ECG signal based on discrete wavelet transform (DWT) and adaptive filtering techniques. The results are compared with the existing notch filter both in time and frequency domain by filter performance parameters like ESD, MSE %PSD and SNR.

KEYWORDS
Adaptive Filter and Filter Performance Parameters, Discrete Wavelet Transform, Electrocardiogram, Power Line Interference

1. INTRODUCTION
Signal processing techniques have diversified applications in the field of biomedical engineering, sonar, acoustics, radars, speech communication, data communication, seismology and many others. In biomedical applications, they are widely used to analyze biopotential signals such as Electrocardiogram (ECG), Electroencephalogram (EEG) to remove various noises added and to extract some vital parameters for

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prognosis and treatment. The biopotential signals are corrupted by various noises such as a) power line interference b) base line drift c) motion artifacts d) muscle contraction e) electrode contact noise f) electrosurgical noise etc. Signal processing techniques can be used remove the various noises that are added to the biopotential signals. The use of computers in biomedical signal analysis lies in the potential use of signal processing algorithms and modeling technique for the quantitative analysis. In this proposed work ECG is the biopotential signal considered for the analysis and different techniques for the removal of Power Line Interference (PLI) noise in ECG signal are being investigated (Kadam & Bhaskar, 2012).

Electrocardiography (ECG) is an important clinical tool used to investigate the activities of the heart and to identify the various heart diseases and the abnormalities in the heart. A typical ECG tracing of a normal heart beat which is called as cardiac cycle consists of a P wave, a QRS complex and a T wave. Figure 1(a) illustrates the typical ECG trace of a normal human subject. The normal values of amplitude and duration of ECG parameters are shown in Table 1. As seen from the specifications of normal ECG signal the amplitude is very small (1mv to 3mv) and the frequency range of 0.05Hz to 150Hz. For such small amplitude and low frequency signal noise gets added up and corrupts the vital information of the signal. Hence, it becomes necessary to remove the noises present in the ECG signal so that it can be analyzed with clinical standards. Among all the noises the power line interference is very crucial because it lies in the ECG bandwidth. Many researches have worked on development of methods

Figure 1. Normal ECG trace
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