ECG Signal Denoising Using Wavelet Thresholding Techniques in Human Stress Assessment

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Abstract: In recent years, Electrocardiogram (ECG) plays an imperative role in heart disease diagnostics, Human Computer Interface (HCI), stress and emotional states assessment, etc. In general, ECG signals affected by noises such as baseline wandering, power line interference, electromagnetic interference, and high frequency noises during data acquisition. In order to retain the ECG signal morphology, several researches have adopted using different preprocessing methods. In this work, the stroop color word test based mental stress inducement have done and ECG signals are acquired from 10 female subjects in the age range of 20 years to 25 years. We have considered the Discrete Wavelet Transform (DWT) based wavelet denoising have incorporated using different thresholding techniques to remove three major sources of noises from the acquired ECG signals namely, power line interference, baseline wandering, and high frequency noises. Three wavelet functions ("*db4", "coif5"* and "*sym7"*) and four different thresholding methods are used to denoise the noise in ECG signals. The experimental result shows the significant reduction of above considered noises and it retains the ECG signal morphology effectively. Four different performance measures were considered to select the appropriate wavelet function and thresholding rule for efficient noise removal methods such as, Signal to Interference Ratio (SIR), noise power, Percentage Root Mean Square Difference (PRD) and finally periodogramof Power Spectral Density (PSD). The experimental result shows the *"coif5"* wavelet andrigrsurethresholding rule is optimal for unknown Signal to Noise Ratio (SNR) in the real time ECG signals.

Keywords: Electrocardiogram, Discrete Wavelet Transform, Thresholding, Baseline Wandering, Power Line Interference.

1. Introduction

Electrocardiogram (ECG) signal is a graphical representation of cardiac activity and it uses the primary measure for identifying various heart diseases and heart abnormalities. In general, ECG signals have unique morphological characteristics (P-QRS-T complex) and it is highly significant than other biological signals. It is possible to diagnose many cardiac diseases by analyzing the variations of this morphology visually. However, the presence of noises in ECG signals will severely affect the visual diagnosis and feature extraction of various applications (stress measurement, emotion estimation and human computer interfaces, etc.). In order eliminate the noises and to extract the efficient morphology of ECG signals, several preprocessing methods have been proposed over past few decades [1-5]. Many of the researchers have used digital Infinite Impulse Response (IIR) filter to remove the effects of power line interference and baseline wander from ECG signals [4, 6]. Because, the design of IIR filter is simple, on other hand, higher order IIR filters are performing well to remove the noises from the signals. However, it has the drawback of increased filtering time, memory and incapable to filter the highly non-linear signals in the entire ECG range. Recent years, adaptive

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