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INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES
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MANAGEMENT

BASELINE DRIFT REMOVAL USING WAVELET DECOMPOSITION

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Abstract

Baseline drift elimination is considered a classical problem. In electrocardiography (ECG) signals, baseline drift can influence the accurate diagnosis of heart disease such as ischemia and arrhythmia. We present a wavelet-transform- (WT-) based search algorithm using the energy of the signal in different scales to isolate baseline drift from the ECG signal. The algorithm computes wavelet decomposition and then in each scale the energy of the signal is calculated.

Keywords— Electrocardiography, Wavelet Decomposition.

Introduction

In recent years computer aided ECG signal analysis has gained momentum and a tremendous amount of work has been carried out. One area of interest has been removing artifacts from data records [1, 2]. Artifacts are the noise induced to ECG signals that result from movements of electrodes. This in turn causes deformation and change in the electrical characteristics of the skin under and around the electrodes. These electrical changes appear in the ECG as motion artifacts and baseline drifts. Baseline wanders are considered as an artifact which produces inaccurate data when measuring the ECG parameters. The ST-segment measures are especially strongly affected by this wandering. In most of the ECG recordings the respiration, electrode impedance changes due to perspiration and increased body movements are the main causes of the baseline wandering [3]. Therefore, elimination of the baseline drifts can very much change the clinical information of the ECG signal.

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Related Work

In [4], digital linear phase high-pass filter is used which decreases undesirable distortion of ECG signal. It requires a multi rate architecture having linear low pass filter working at low sampling rate with cut-off frequency of 0.9 Hz. But it requires large computational complexity.

Another method for estimating the baseline drift is cubic spline fitting [5]. In this method low-frequency noise superimposed on the baseline may be removed without affecting ST-segments. Rapid, simplified computations are accomplished using state-space techniques. This is a nonlinear method, and its performance is based on estimation of reference points in the PR intervals. The main disadvantage of this method is estimating reference points that may not belong to baseline.

Some transform methods are also used for baseline drifts. In [6], Short time Fourier transform (STFT) used to detect the presence of baseline drift in ECG signal and use a time-varying filter. This method has two problems. First, STFT cannot have good time and frequency resolution at the same time. Second, it will have the same problems that are associated with filtering that is already mentioned above.

Overview

Electrocardiogram (ECG)

Electrocardiogram, also known as EKG (from the German language) is a method of recording the electrical activity of the heart. Each heartbeat is caused by a section of the heart generating an electrical signal, which then conducts through specialized pathways to all parts of the heart. These electrical signals also get transmitted through the chest to the skin where they can be recorded as a graph.

Wavelets

A wavelet is a wave-like oscillation with an amplitude that starts out at zero, increases, and then decreases back to zero. It can typically be visualized as a "brief oscillation" like one might see recorded by a seismograph or heart monitor. Generally, wavelets are purposefully crafted to have specific properties that make them useful for signal processing. Wavelets can be combined, using a "reverse, shift, multiply and sum" technique called convolution, with portions of an unknown signal to extract information from the unknown signal.

In other words wavelet is a mathematical function used to divide a given function or continuous-time signal into different scale components. Usually one can assign a frequency range to each scale component. Each scale component can then be studied with a resolution that matches its scale. A wavelet transform is the representation of a function by wavelets.

Wavelet packet decomposition

Wavelet packet decomposition is a wavelet transform where the signal is passed through more filters than the discrete wavelet transform (DWT).

Method

In this section we discuss about the algorithm that we use for removal of baseline drift in ECG signal. This method is based on wavelet decomposition (sometimes known as just wavelet packets). The Daubechies wavelets are a family of orthogonal wavelets defining a discrete wavelet transform and characterized by a maximal number of vanishing moments for some given support. With each wavelet type of this class, there is a scaling function (called the father wavelet) which generates an orthogonal multi resolution analysis.

In general the Daubechies wavelets are chosen to have the highest number A of vanishing moments, (this does not imply the best smoothness) for given support width N=2A, and among the 2A−1 possible solutions the one is chosen whose scaling filter has external phase. The wavelet transform is also easy to put into practice using the fast wavelet transform. Daubechies wavelets are widely used in solving a broad range of problems, e.g. self-similarity properties of a signal or fractal problems, signal discontinuities, etc.

Simulation Results

Original signal of ECG taken as input which is combination two signals overlapped each other and the because of baseline drift signal properties varies .the above graph shows the discrete value between time and voltage.

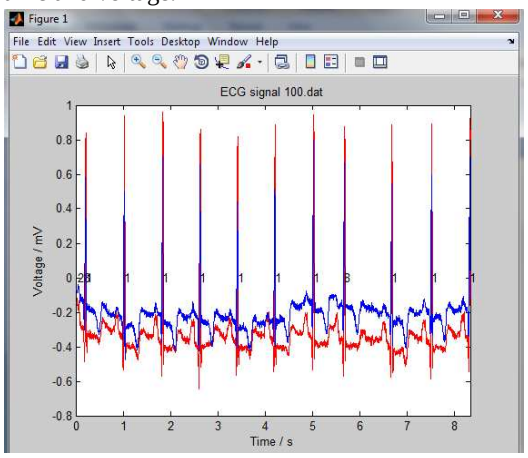

Figure1: Discrete value between time and voltage (in mv)

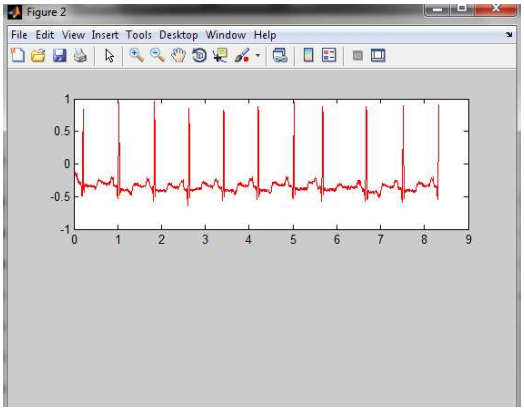

Figure2: Separated ecg signals from the orginal one which having originally base line drift value.

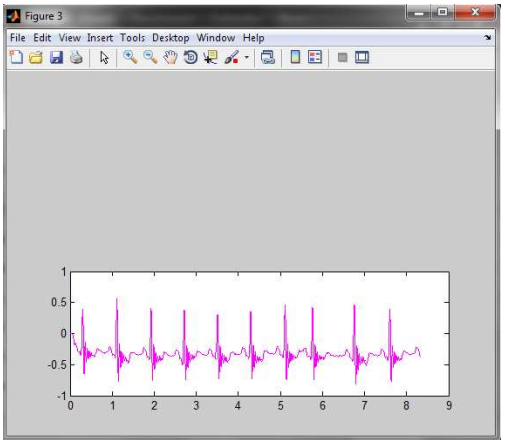

Figure3: Separated second ecg signal from the orginal one which having originally base line drift value.

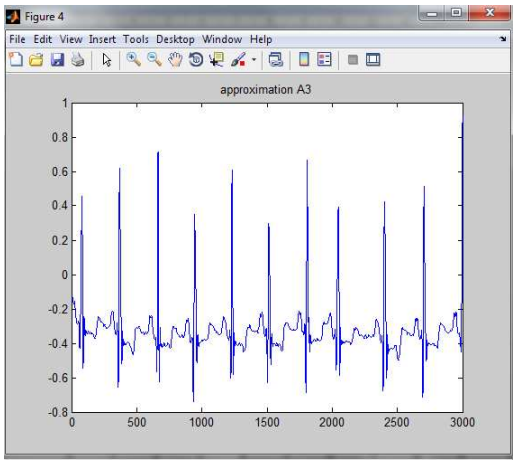

Figure4: Wavelet decomposition of ECG signal

The above graph shows the wavelet decomposition of ECG signal which having initially baseline drifts.

The signal is decomposed in approximation level which having highest energy level, after first level decomposition the wavelet graph become:

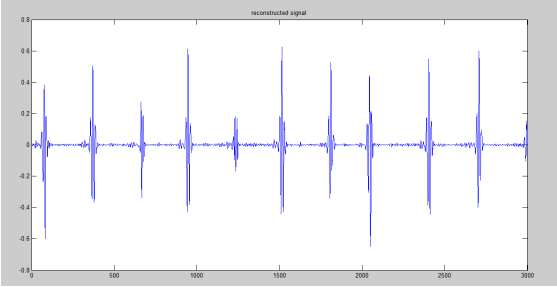

Figure5: Reconstructed signal after removing the baseline drift

Conclusion

In this paper we presented an algorithm based on wavelet decomposition for removing baseline drifts in ECG signal. It has been shown that the presented algorithm can eliminate the baseline drifts from ECG signals. Daubechies wavelets have good compression property for wavelet coefficients.

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