# ECG Signal Compression Technique based on DWT & QRS Complex Estimation

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***Abstract*— In this paper, an Electrocardiogram (ECG) signal is compressed based on discrete wavelet transform (DWT) and QRS-complex estimation .The electrocardiogram (ECG) is widely used for judgment of heart diseases. Generally, the recorded ECG signal is often tainted by noise. In order to extract useful information from the noisy ECG signals, the raw ECG signals has to be processed. The baseline wandering is significant and can strongly affect ECG signal analysis. The detection of QRS complexes in an ECG signal provides information about the heart rate, the conduction velocity, the condition of tissues within the heart as well as various abnormalities. It supplies evidence for the diagnosis of cardiac diseases. An algorithm based on wavelet transforms (WT's) has been developed for detecting ECG characteristic points. Although digital storage media is not expensive and computational power has exponentially increased in past few years, the possibility of electrocardiogram (ECG) compression static interests the attention, due to the huge amount of data that has to be stored and transmitted The main features of this compression algorithm are the use of less memory due to compression, high efficiency and high speed.**

***Keywords*— *ECG,QRS complex , Wavelet Transform, Compression, QRS Detection, DWT***

## I. INTRODUCTION

An Electrocardiogram (ECG) is simply a measure of voltage changes in the body. ECG signal is electrical activity of heart and it is used to measure the rate and uniformity of heartbeats. The electrically-active tissues in the body are the muscles and nerves. Small brief changes in voltage can be detected as these tissues 'fire' electrically. The heart is a muscle with well-coordinated electrical activity, so the electrical activity within the heart can be easily detected from the outside of the body.

The ECG signal is preprocessed by normalization and mean removal. Then, an error signal is formed as the difference between the preprocessed ECG signal and the estimated QRS-complex waveform. Transform based compression using the wavelet transform (WT) is an efficient and flexible. This error signal is wavelet transformed and the resulting wavelet coefficients are threshold by setting to zero all coefficients that are smaller than certain threshold levels. The threshold levels of all subbands are calculated based on Energy Packing Efficiency (EPE) such that minimum percentage root mean square difference (PRD) and maximum compression ratio (CR) are obtained high CR associated with low distortion level relative to previously reported compression algorithms.

## II. BLOCK DIAGRAM

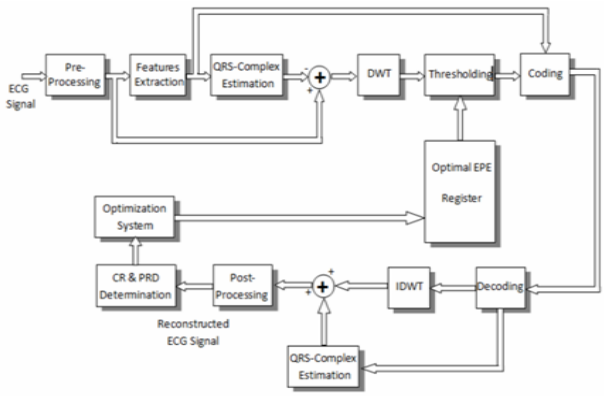


Fig.1. Block diagram of ECG compression algorithm [1]

### A. *Pre-processing*

The aim of pre-processing steps is to improve the general quality of ECG for more accurate analysis and measurement. Noises may disturb ECG to such an extent that measurements from original signals are unreliable. The objective of ECG signal processing is to improve the measurement accuracy. Though the extraction of information is not readily available from visual assessment, pre-processing of ECG signal is very important.

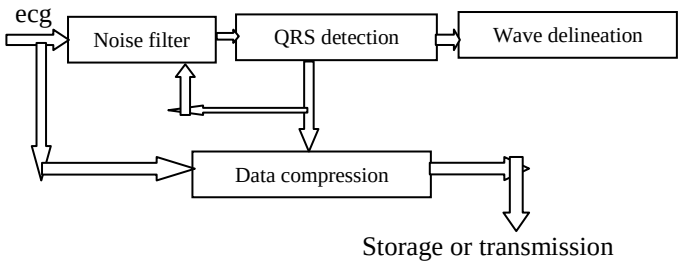


Fig.2.Block diagram of ECG signal pre-processing [2]

This is the original ECG signal having noise and various types of distortion and is removed using Savitzky Golay filter.

In ECG Noise Filtering, we use Savitzky Golay Filter to remove the noise. Savitzky Golay filter is a digital filter that can be applied to set of digital data point for the purpose of smoothing the data and it is used to increase the signal to noise ratio without greatly distorting the signal.

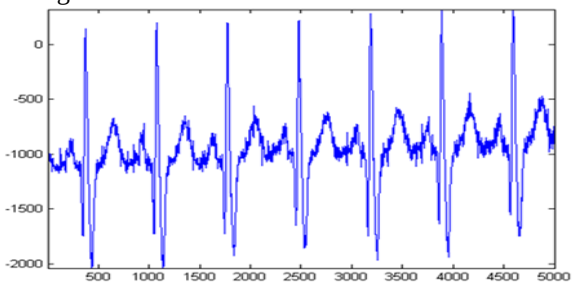


Fig.3.Input ECG signal

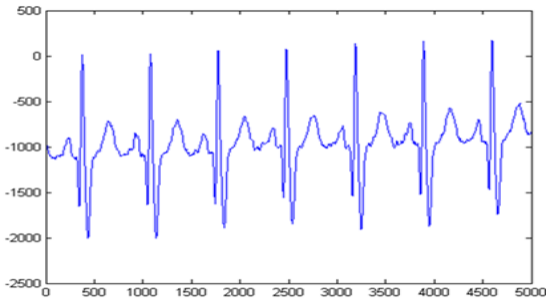


Fig.4. Output of filtered ECG signal using Savitzky Golay filter

### *B. QRS-Complex detection*

A typical scalar ECG heartbeat is shown in below. The important features of the ECG waveform are the P, Q, R, S and T waves and the duration of each wav is shown.

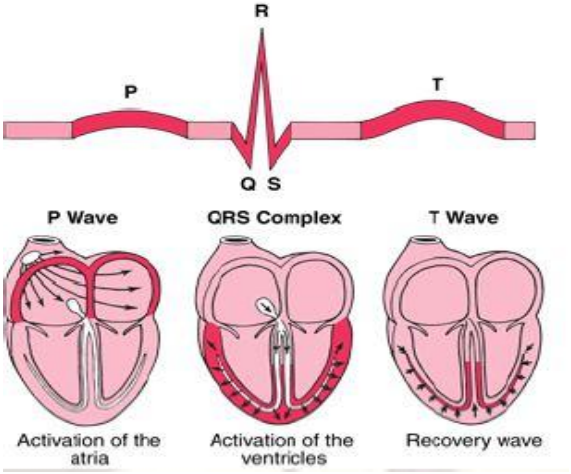


Fig.5.Schematic Represntation of Normal ECG [3]

A typical ECG tracing of electrocardiogram baseline voltage is known as the isoelectric line. It is measured as the portion of the tracing following the T wave and preceding the next P wave. The aim of the QRS-complex estimation is to produce the typical QRS-complex waveform using the parameters extracted from the original ECG signal. The estimation procedure is a Matlab based estimator and is able to produce normal QRS waveform. A single heartbeat of ECG signal is a mixture of triangular and sinusoidal wave forms. The QRS-complex wave can be represented by shifted and scaled versions of these waveforms. The ECG waveform contains, in addition to the QRS-complex, P and T waves, 60-Hz noise from power line intervention, ECG signal from muscles, motion piece from the electrode and skin interface, and possibly other interference from electrosurgery.

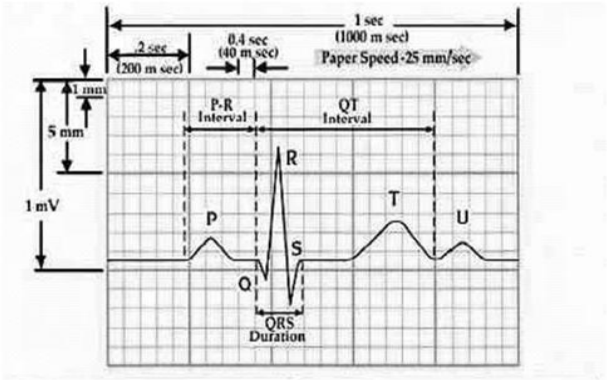


Fig.6.Typical ECG signal [1]

For QRS detection, we have used Pan-Tompkins algorithm.

In QRS Detection, we use PAN TOMPKINS ALGORITHM, it recognizes QRS complexes based on analysis of slope, amplitude and width. Pan Tompkins algorithm is real time algorithm and this algorithm detect 99.3% of QRS complex

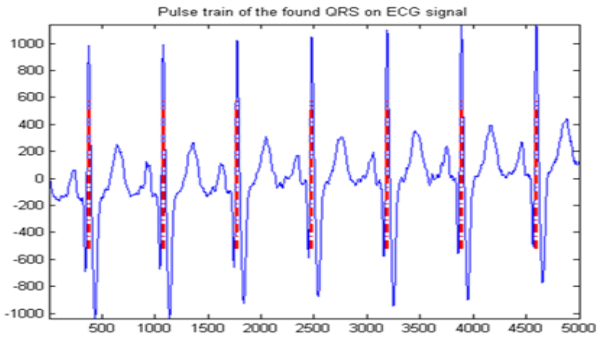


Fig.7.Output of QRS Detection using Pan-Tompkins Algorithm

### C. *Compression*

In compression techniques we use DWT compression techniques. for compression we first reconstruct the original signal and then parameters measure and in parameter measure there is three parameter to measure and they are

a. Percentage root means different[PRD]

b. Error ratio[ER]

c. Compression ratio[CR]

DWT is a The discrete wavelet transform represents the digital signal with respect to time using various filtering techniques. Various cutoff frequencies at multiple scales are used to examine the signal. Filters perform the functions to process the signal. Scaling the filters in iterations produces wavelets. Scales are determined using up and down sample method. The use of filters provides the information in the signal.

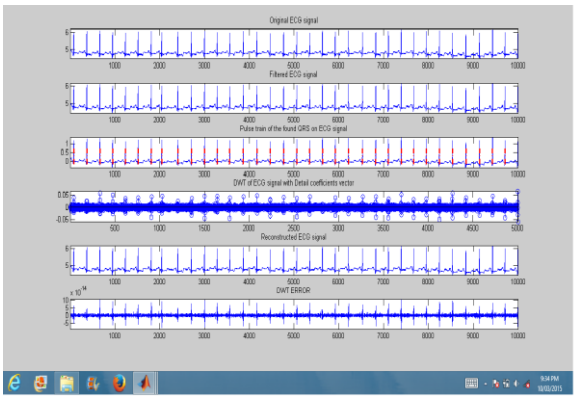

Fig.8. Output of DWT & IDWT

After this compression, we will reconstruct this ECG signal using inverse discrete Wavelet transform (IDWT). By following this step we will get original signal.

### D. *Performance measure*

**a. PRD**: The percentage root mean-square difference (PRD) is a frequently employed distortion measure that quantifies the error between the original signal and the reconstructed signal.

**b. Compression Ratio**: It is the ratio of bit rate of original signal to the bit rate of compressed signal.

**c. Error Rate**: The error between the original signal and the reconstructed signal.

## III.CONCLUSION

In this paper, a new method for compressing ECG signal based on wavelet transform has been proposed. The key idea lies in the determination of QRS-complex signal from a given ECG signal. The QRS-complex is estimated using parameters extracted from the original ECG signal. A wavelet-based ECG data compression is better than the others used for comparison. The high efficiency, high speed and ease make the algorithm an attractive choice for use in convenient heart observing systems.

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