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Design of Low Complexity Programmable Fir Filters Based On ECG Compression by Using the Discrete Wavelet Transform

Jeya Shenbagavalli.J[1], M.Ashok Kumar[2]

P.G Student, Dept. of ECE, ACE, Hosur, Tamilnadu, India[1]

Associate Professor, Dept. of ECE, ACE, Hosur, Tamilnadu, India [2]

ABSTRACT: This project presents FPGA design of ECG compression by using the Discrete Wavelet Transform (DWT) with FIR. Unlike the classical works based on off-line mode, the current work allows the real-time processing of the ECG signal to reduce the redundant information. A model is developed for a fixed-point convolution scheme which has a good performance in relation to the throughput, the latency, the maximum frequency of operation and the quality of the compressed signal. The quantization of the coefficients of the filters and the selected fixed-threshold give a low error in relation to clinical applications. Low-cost finite impulse response (FIR) designs are presented for this project. We jointly consider the optimization of bit width and hardware resources without sacrificing the frequency response and output signal precision. No uniform coefficient quantization with proper filter order is proposed to minimize total area cost. Multiple constant multiplication / accumulation in a direct FIR structure are implemented using an improved version of truncated multipliers.

KEYWORDS: DWT,FIR,ECG

I.INTRODUCTION

Electro Cardio Gram (ECG) is an important signal for cardiovascular diagnosis. ECG signal compressionis done to separate the valid signal components from the undesired artifacts so as to obtain accurate ECGsignal. Discrete Wavelet Transform (DWT) is a widely used technique for signal and image compression. The multi-resolution property of DWT decomposes the signal into scaling function (low pass filter) and wavelet function (high pass filter) respectively. DWT is implemented by Finite Impulse Response (FIR) bank structures. The performanceevaluation of ECG compression algorithm includes three components: compression efficiency (i.e.,Compression Ratio), reconstruction error (i.e., Percentage Root Deviation) and the computational complexity.

II.ECG SIGNAL DESCRIPTION

ECG are used in catherization laboratories, coronary care units and for routine diagnostic applications in cardiology. cardiologist readily interprets the ECG waveforms and classifies them into normal and abnormal pattern.ECG signals are formed of P wave, QRS complex, T wave. The change in these parameters indicate illness of heart that may occur many reasons. For achieve spike free signal we use filter.

A filter is a circuit which amplifies some frequencies applied to its input and attenuates others. There are four common types of filter used which is high pass, which amplifies frequencies above a certain value, low pass filter which amplifies below certain value ,band pass filter which amplifies frequencies a certain band. Filters has two types which is analog and digital. Analog filter require more mathematical calculation but digital filter require no more calculation.

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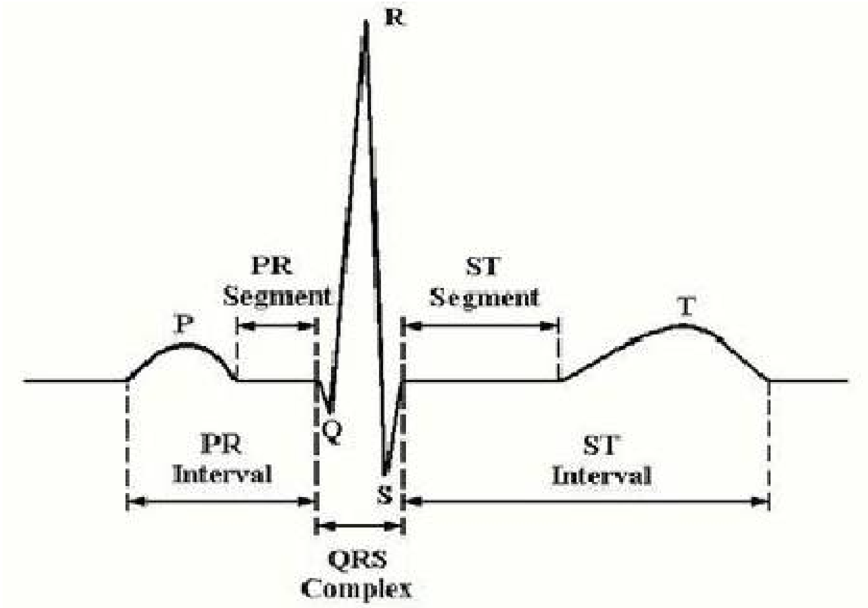

Fig.1.ECG waveform

III.ECG SIGNAL COMPRESSION

1. **Direct Signal Compression Techniques:** Direct methods involve the compression performed directly on the ECG signal. These are also known as time domain techniques dedicated to compression of ECG signal through the extraction of a subset of significant samples from the original sample set. Which signal samples are significant, depends on the underlying criterion for the sample selection process. To get a high performancetimedomaincompression algorithm, much effort should be put in designing intelligent sample selection criteria. The original signal is reconstructed by an inverse process, most often by drawing straight lines between the extracted samples. This category includes the FAN (Dipersio& Barr, 1985), CORTES (Abenstein& Tompkins, 1982), AZTEC (Cox et al., 1968), Turning Point (Mueller W., 1978) and TRIM (Moody et al., 1989) algorithms. The more recent cardinality constrained shortest path technique (Haugland et al., 1997) also fits into this category. Many of the time domain techniques for ECG signal compression are based on the idea of extracting a subset of significant signal samples to represent the original signal. The key to a successful algorithm is the development of a good rule for determining the most significant samples. Decoding is based on interpolating this subset of samples. The traditional ECG time domain compression algorithms all have in common that they are based on heuristics in the sample selection process. This generally makes them fast, but they all suffer from sub-optimality.

2. **Transformed ECG Compression Methods:** Transform domain methods, as their name implies, operate by first transforming the ECG signal into another domain. These methods mainly utilize the spectral and energy distributions of the signal by means of some transform, and properly encoding the transformed output. Signal reconstruction is achieved by an inverse transformation process. This category includes traditional transform coding techniques applied to ECG signals such as the Karhunen–Loèvetransform (Olmos et al., 1996), Fourier transform (Reddy & Murthy, 1986), Cosine transform (Ahmed et al., 1975), subband-techniques (Husøy&Gjerde, (1996), vector quantization (VQ) (Mammen&Ramamurthi, 1990), and more recently the wavelet transform (WT) (Chen et al., 1993; (Miaou et al.., 2002). Wavelet technique is the obvious choice for ECG signal compression because of its localized and non-stationary property and the well-proven ability of wavelets to see through signals at different resolutions. Wavelets are mathematical functions that cut up data into different scale-shift components. The wavelet decomposition splits the analyzing signal into average and detail coefficients, using finite impulse response digital filters. The main task in wavelet analysis (decomposition and reconstruction) is to find a good analyzing function

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(mother wavelet) to perform an optimal decomposition. Wavelet-based ECG compression methods have been proved to perform well. The ability of DWT to separate out pertinent signal components has led to a number of wavelet-based techniques which supersede those based on traditional Fourier methods. The discrete wavelet transform has interesting mathematics and fits in with standard signal filtering and encoding methodologies. It produces few coefficients, and the user does not have to worry about losing energy during the transform process or its inverse. While the DWT is faster and maps quickly to the sub-band coding of signals, the Continuous Wavelet Transform (CWT) allows the user to analyze the signal at various scales and translations according to the problem.

3. **Optimization Methods For ECG Compression:** More recently, many interesting optimization based ECG compression methods, the third category, have been developed. The goal of most of these methods is to minimize the reconstruction errorgiven a bound on the number of samples to be extracted or the quality of the reconstructed signal to be achieved. In (Haugland et al., 1997), the goal is to minimize the reconstruction error given a bound on the number of samples to be extracted. The ECG signal is compressed by extracting the signal samples that, after interpolation, will best represent the original signal given an upper bound on their number. After the samples are extracted they are Huffman encoded. This leads to the best possible representation in terms of the number of extracted signal samples, but not necessarily in terms of bits used to encode such samples. In (Nygaardet al., 1999), the bit rate has been taken into consideration in the optimization process.

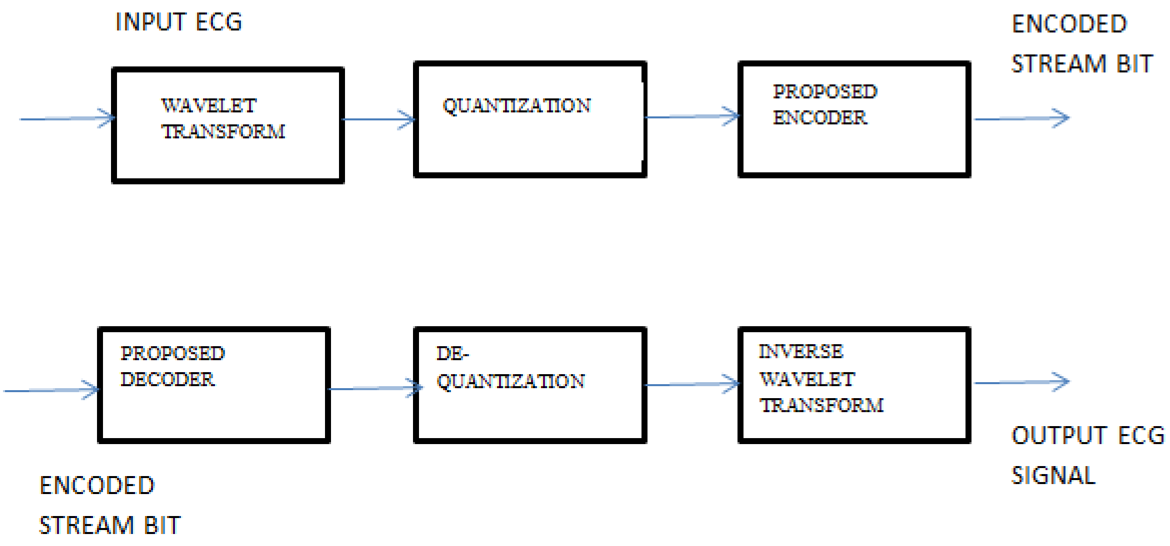

Fig.2. Block Diagram Of ECG Compression

IV. WAVELET TRANSFORM

1.DISCRETE WAVELET TRANSFORM

There are different transform techniques such as DFT,STFT, DCT and DWT. Among these different transform techniques, DWT is an appropriate tool for ECG signal compression. The DWT is a recursive filtering process. At each level, the input data is filtered by two filters to produce two result data-streams. These data-streams are then sub samples by two to reduce the output to the same number of data words as the original signal. The low pass filter output of this result is the further processed by the same two filters, and this continues recursively. Thus the input signal data-stream is decomposed into approximation (low pass filter) and details (high pass filter) data-streams respectively.The compression of the signal is done using the modelsim tool.

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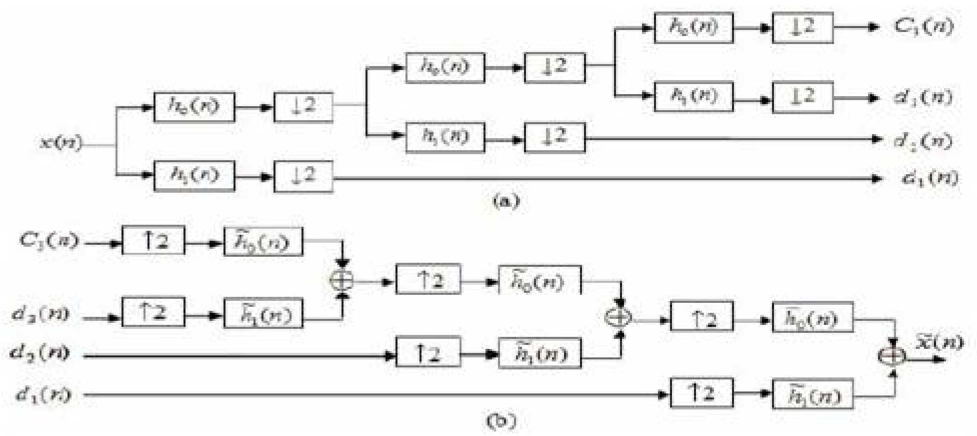
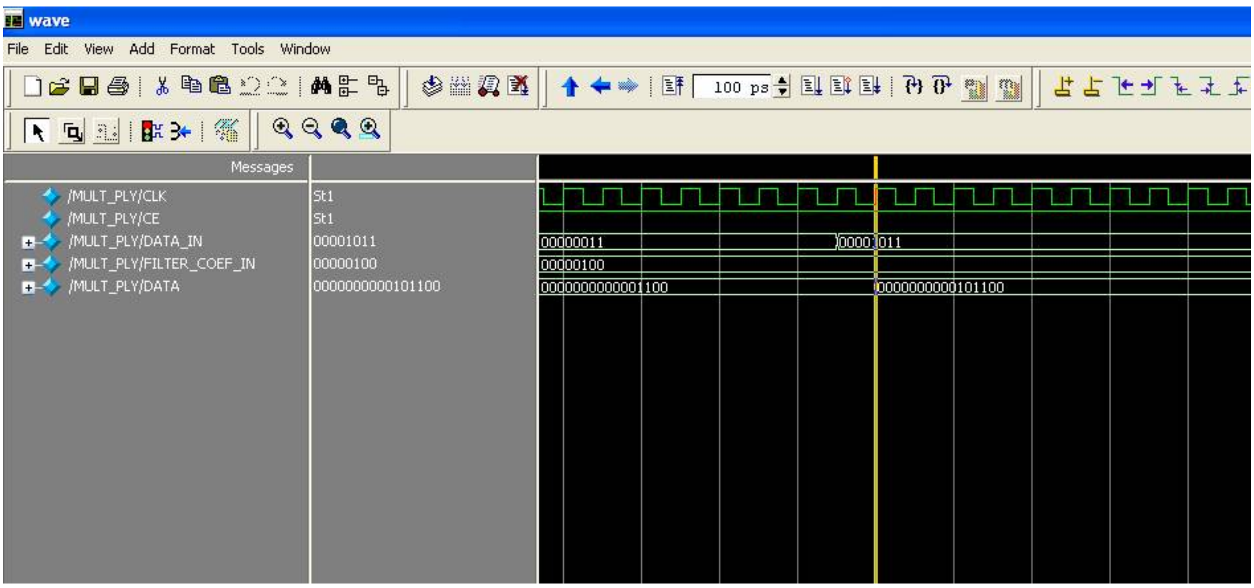


Fig.3. A three-level two-channel iterative filter bank (a) forward DWT (b)inverse DWT

V.OUTPUT SCREEN



V1.CONCLUSION

They may be defined either as reversible methods (offering low compression ratios but guaranteeing an exact or near-lossless signal reconstruction), irreversible methods (designed for higher compression ratios at the cost of a quality loss that must be controlled and characterized), or scalable methods (fully adapted to data transmission purposes and enabling lossyreconstruction). Choosing one method mainly depends on the use of the ECG signal.
In the case of the needs of a first diagnosis, a reversible compression would be most suitable. The data compression can be done many methods so that signals are compressed as much as possible for better enhancement of the signals.

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