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Study of ECG Signal Compression using modified discrete cosine and discrete wavelet transforms

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Abstract— **A new hybrid two-stage electrocardiogram (ECG) signal compression method based on the modified discrete cosine transform (MDCT) and discrete wavelet transform (DWT) is proposed. The ECG signal is partitioned into blocks and the MDCT is applied to each block to decorrelate the spectral information. Then, the DWT is applied to the resulting MDCT coefficients. Removing spectral redundancy is achieved by compressing the subordinate components more than the dominant components. The resulting wavelet coefficients are then thresholded and compressed using energy packing and binary-significant map coding technique for storage space saving. Experiments on ECG records from the MIT-BIH database are performed with various combinations of MDCT and wavelet filters at different transformation levels, and quantization intervals. The decompressed signals are evaluated using percentage rms error (PRD) and zero-mean rms error (PRD1) measures. The results showed that the proposed method provides low bit-rate and high quality of the reconstructed signal. It offers average compression ratio (CR) of 21.5 and PRD of 5.89%, which would be suitable for most monitoring and diagnoses applications. Simulation results show that the proposed method compares favourably with various state-of-the-art ECG compressors.**

Index Terms—**Data compression; Electrocardiogram; Wavelet transform; Discrete cosine transform; Energy packing; Binary-significant map coding.**

I. INTRODUCTION

Compression techniques have been around for many years. However, there is still a continual need for the advancement of algorithms adapted for ECG signal compression. The necessity of better ECG signal compression methods is even greater today than just a few years ago for several reasons. The quantity of ECG records is increasing by the millions each year, and previous records cannot be deleted since one of the most important uses of ECG signal is in the comparison of records obtained over a long range period of time. The ECG signal compression techniques are limited to the amount of time required for compression and reconstruction, the noise embedded in the raw ECG signal, and the need for accurate reconstruction of the P, Q, R, S, and T waves. The results of this research will likely provide an improvement on existing compression techniques, and the original computer program will provide a simple interface so that the cardiologist can use ECG data compression techniques without knowledge of the Specific and mathematics behind the algorithms.

The central goal of electrocardiogram (ECG) data compression techniques is to preserve the most useful diagnostic information while compressing a signal to an acceptable size. Lossless compression is the best choice as long as the compression ratio is acceptable, but it cannot usually offer a satisfactory compression ratio (CR).

To obtain significant signal compression, lossy compression is preferable to a lossless compression. In this case, compression is accomplished by applying an invertible orthogonal transform to the signal, and one tries to reduce the redundancy present in the new representation. Due to its decorrelation and energy compaction properties and to the existence of efficient algorithms to compute it, discrete cosine transform and modified discrete cosine transform have been widely investigated for ECG signal compression. Over the years, a variety of other linear transforms have been developed which include discrete Fourier transform (DFT), discrete wavelet transform (DWT) and many more, each with its own advantages and disadvantages. Among these techniques, DWT has been proven to be very efficient for ECG signal coding. Compared to other methods, DWT has

gained widespread acceptance in signal processing in general and in ECG compression research in particular. In this project, a hybrid two-stage ECG signal compression method based on discrete cosine transform (DCT) and DWT is proposed. Their combination removes the spectral redundancy by compressing the subordinate components more than the dominant components. The resulting transformed coefficients that represent the transformational signal are then thresholded and compressed using a new coding technique for storage space saving.

II. SYSTEM

Over the years, a variety of other linear transforms have been developed which include discrete Fourier transform (DFT), discrete wavelet transform (DWT) and discrete cosine transform (DCT) and many more, each with its own advantages and disadvantages. Among these techniques, DWT has been proven to be very efficient for ECG signal coding.

It is proposed to develop, a hybrid two-stage ECG signal compressor based on discrete cosine transforms (DCT) and discrete wavelet transforms DWT, which will be suitable for most monitoring and diagnostic applications as well as Telemedicine.

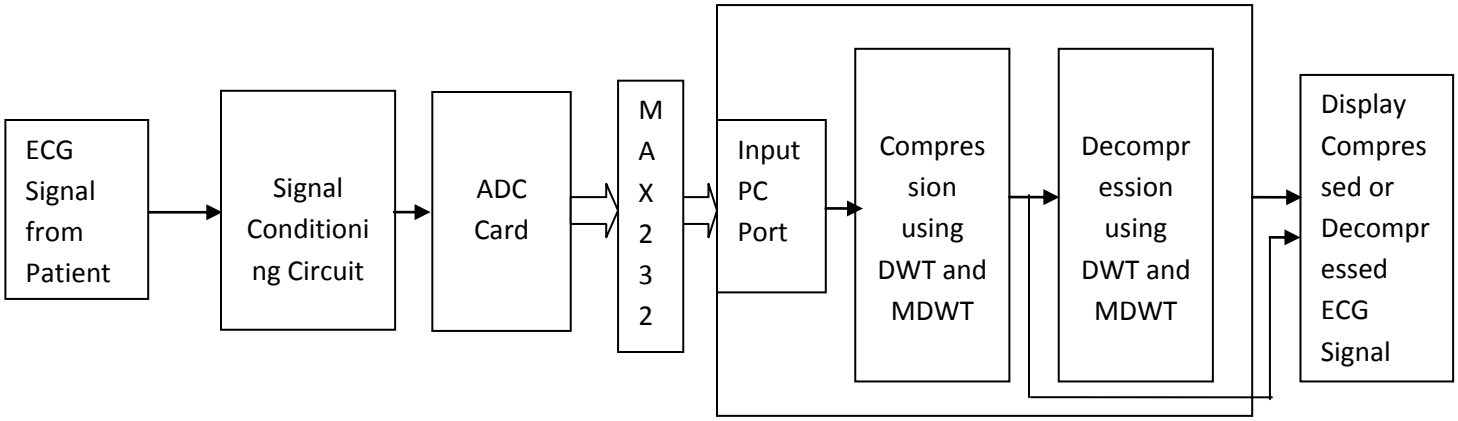

Figure 1. Generalized Block Diagram

Signal Conditioning Circuit-

Signal conditioning means manipulating an analog signal in such a way that it meets the requirements of the next stage for further processing. Most common use is in analog-to-digital converters.

ADC Card-

An analog-to-digital converter is a device that uses sampling to convert a continuous quantity to a discrete time representation in digital form. The reverse operation is performed by a digital-to-analog converter (DAC).

MAX 232-

The MAX232 is an integrated circuit that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. The MAX232 is a dual driver/receiver and has pins like RX, TX, CTS and RTS signals. The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single + 5 V supply via on-chip charge pumps and external capacitors. This makes it useful for implementing RS-232 in devices that otherwise do not need any voltages outside the 0 V to + 5 V range.

Compression & de compression using DWT & MDCT-

For compression of ECG signal Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) methods will be used. For implementing the algorithms of DCT and DWT MATLAB along with Signal Processing & DWT toolbox will be used. And if required C and C++ programming can be used.

III. APPLICATIONS

modified discrete cosine and discrete wavelet transforms based systems has wide applications. We discuss some application in this paper.

A. Combined DWT-DCT Digital Image Watermarking

combined DWT-DCT digital image watermarking algorithm. The algorithm watermarks a given digital

image using a combination of the Discrete Wavelet Transform (DWT) and the Discrete Cosine Transform (DCT). Performance evaluation results show that combining the two transforms improved the performance of the watermarking algorithms that are based solely on the DWT transform.

B. Integrating DCT and DWT for approximating cube streams

For time-relevant multi-dimensional data sets (MDS), users usually pose a huge amount of data due to the large dimensionality, and approximating query processing has emerged as a viable solution. Specifically, the cube streams handle MDSs in a continuous manner. Traditional cube approximation focuses on generating single snapshots rather than continuous ones. the DAWA algorithm, standing for a hybrid algorithm of DCT for Data and discrete Wavelet transform, is proposed to approximate the cube streams. The DAWA algorithm combines the advantage of high compression rate from DWT and that of low memory cost from DCT. Consequently, DAWA costs much smaller working buffer and outperforms both DWT-based and DCT-based methods in execution efficiency.

C. A Novel Synchronization Invariant Audio Watermarking Scheme Based on DWT and DCT

Synchronization attack is one of the key issues of digital audio watermarking. In this correspondence, a blind digital audio watermarking scheme against synchronization attack using adaptive quantization is proposed. The features of the proposed scheme are as follows: 1) a kind of more steady synchronization code and a new embedded strategy are adopted to resist the synchronization attack more effectively; 2) he multiresolution characteristics of discrete wavelet transform (DWT) and the energy-compression characteristics of discrete cosine transform (DCT) are combined to improve the transparency of digital watermark; 3) the watermark is embedded into the low frequency components by adaptive quantization according to human auditory masking; and 4) the scheme can extract the watermark without the help of the original digital audio signal.

IV. CONCLUSION

a hybrid ECG compression technique based on wavelet transformation of the MDCT coefficients of the signal. Interaction of MDCT analysis with DWT transformations, signals thresholding and coding are a few of the many outstanding challenges in ECG compression. The performance of the algorithm is tested by coding two records in MIT-BIH ECG arrhythmia database. Results obtained by running the compressor on the first two minutes of records 117 and 119 and adopting different MDCT and DWTs show that the proposed method offers average CR of 21.5 and PRD of 5.89%, which would be suitable for most monitoring and diagnostic applications

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