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AN EFFICIENT EMBEDDED COMPRESSION TECHNIQUE FOR REDUCING DELAY IN HD VIDEO COMPRESSION

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ABSTRACT

At present, the HD (High Definition) video compression techniques involves high complexity and delay. This is because of its high-resolution. The motive is to reduce the delay taken for compression of video. Here a low-complexity lossless/near lossless video codec design is presented. It aims at serving as an embedded compression technique to reduce the delay for high definition video compression over wireless networks. The design feature is best trade off in complexity and efficiency. For video test set consisting of previously encoded full HD and non-full HD sequences, the compression efficiency of Context based Adaptive Lossless Image Coding (CALIC) and Wavelet transform methods needs to be improved. The main objective is to propose another algorithm which reduces the delay and also to increase the compression efficiency by retaining the quality of original video.

Index Terms: Video compression, Delay, Embedded compression, DTCWT, Wavelet Transform, Fractal Image Compression.

I. INTRODUCTION

We are in a world of multimedia. Storage and transmission of image and video data requires the development of compression methods. In international standards such as JPEG, JPEG-2000, H.263 and MPEG-4 compression efficiency can be improved by ignoring the quality of the image and video content. But in lossless compression the original data must be pre-served. H.264, Advanced Video Coding (AVC) is a technique that is used for recording, compression, and transmission of video. The main motive of H.264/AVC is to provide good quality video at lower bitrates than previous standards without increasing design comp-lexity. But it does not satisfactorily improves comp-ression efficiency.

Nowadays in communication the main problem with video is its larger size. So, video compression is required to save storage space. The most commonly used compression techniques find redundancies in the movie frames and the correlation between the scene to increase the efficiency of compression. DWT decom-pose the video frames into different subband images namely LL, LH, HL and HH [16]. The frequency component of the subbands contains full frequency spectrum of the original image. Interpolation was applied to all of these subbands. The low resolution image was obtained by filtering the high resolution image using low pass filter. The low resolution image (LL-subband) was given as input in this resolution enhancement process. Adjacent pixel algorithm was used for the process of interpolation. In parallel the low resolution image was interpolated separately. Finally Inverse DWT was carried out to combine both the high frequency subband images and interpolated image to achieve a high resolution output image. Discrete wave-let transform has several drawbacks such as Poor directional selectivity, Longer compression time, Shift variance, High cost of computation, Loss of edge details, etc.

The drawbacks of DWT can be solved by using complex wavelet transform (CWT). But the reconstruct-tion of image in CWT is more complicated. The draw-backs in DWT and CWT can be eliminated by using another wavelet transform method. An expansive transform is used to convert an N-point signal into M coefficients with the condition that M>N. DTCWT provides N multi scales that can be processed using separable efficient Filter Banks. The advantages of DTCWT include Good directional selectivity, Good shift invariance, No data loss, etc. This algorithm will be discussed in the proposed methodology.

II. RELATED WORKS

Stefan Radicke, Qi Wang (2014) have done a study on High Efficiency Video Coding (HEVC) and applied in consumer electronics environments [1]. But the computational complexity was not reduced. The encoding process especially Motion Estimation of HEVC was very time consuming made it impractical for real time applications. A hybrid architecture with a set of algorithms was proposed, where Graphics Processing Unit (GPU) performs both uni-predictive and bi-predictive ME in a parallel manner thereby reducing the complexity. Meanwhile, the Rate-Distortion (RD) performance is almost unaffected.

Gang He, Wei Fei and Satoshi Goto (2014) presented a work on H.264/AVC for UHD video which requires huge throughput and found that design challenges become even more critical [2]. To solve these problems, an interlaced block reordering scheme was first proposed together with a preliminary mode decision (PMD) strategy. Simultaneously hardware cost was also reduced.

Yuan-Hsin Liao, Gwo-Long Li, and Tian-Sheuan Chang(2012) explained that to satisfy the heavy performance requirements for H.264/AVC, it is nece-ssary to design entropy decoder since it dominates the overall decoder throughput. Here they proposed a two-level Context based Adaptive Variable Length Coding decoder that has 21% shorter critical path delay com-pared to the traditional two level decoder design [13].

Jie Dong and Yan Ye(2014) researched that down sampling before the process of encoding and up sampling after the process of decoding can improve the rate distortion (RD) performance rather than directly coding the original video by using standard technologies

(JPEG, H.264/AVC) particularly at low bit rates [3]. Here they have proposed a practical algorithm in order to find the down sampling ratio, thus achieving the overall optimal R-D performance over a wide range of bitrates.

Abbas Javadtalab, Aziz Khanchi and Abdulsalam Yassine (2015) explained that best effort networks affect the quality of video. In this paper they have proposed a Bayesian algorithm and bandwidth change prediction method to detect and identify one-way bandwidth changes at the receiver [4].

III. PROPOSED METHODOLOGY

In many applications the transform must necessarily be invertible. From the factorization process of the Daubechies polynomials it is found that perfect reconstruction (PR) of complex filters does not satisfy frequency selectivity.

A. Dual Tree Complex Wavelet Transform

DTCWT comes with a different approach to overcome this problem. The DTCWT is an extension of discrete wavelet transform (DWT), with properties like shift invariant, good directional selectivity and perfect reconstruction. It achieves a redundancy factor of 2^d for dimensional signals [15]. The multidimensional DTCWT is not separable but it is based on separable Filter Banks (FB).

The DTCWT computes the complex transform of a signal by using two DWT decompositions as shown in figure 1. This transform has the combined properties of both DWT and CWT such as perfect reconstruction, shift invariance and directional selectivity. DWT and DTCWT differ in such a way that DTCWT uses two filter bank trees whereas DWT uses only one. Here we have taken directional filters that find the first derivatives of an image and are designed to function in any direction within a given space. DTCWT decomposes the signal and the first DWT gives the real part while the second DWT gives the imaginary part of the wavelet coefficients.

The downward arrow in the figure shows down sampling by 2. When designed in such a way, the DTCWT achieves shift invariant property. To achieve the relative signal delay, the total delay difference between the given level and the previous levels must be equal to the sum of one sample period at the given level. Therefore the filters below level 2 in one of the tree must provide delays that must be half a sample different from those in the opposite tree. Linear phase filters require odd length filters in one of the tree and even length filters in the other tree. In each tree the first stage filters should differ from all the other later stage filters.

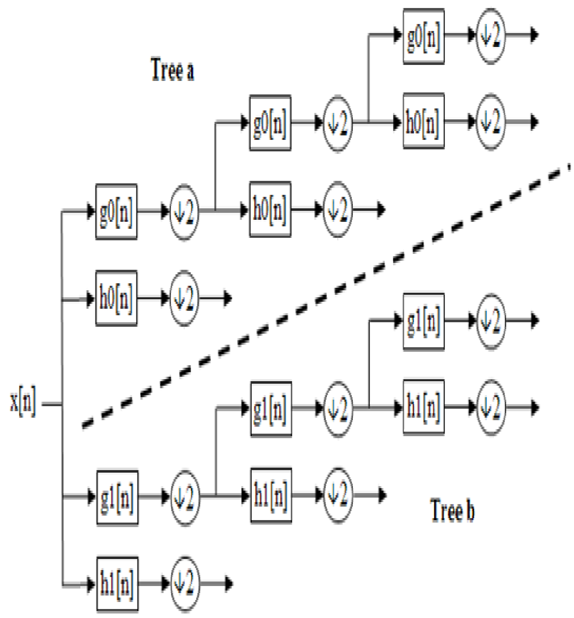


Figure.1 Structure of DTCWT

The steps in the compression of video frames are shown in figure 2 and are explained as follows:

1) The input video is converted into various image frames.

2) Each frame is applied with DTCWT to decompose the wavelet coefficients using two DWT filter bank trees.

3) Frames are compressed using Quad Tree based Fractal Image Compression method.

4) Frames are analyzed to select only the required frames and the similar frames are removed.

5) Selected frames are reordered, sorted and then inverse DTCWT is applied to reconstruct the final output video.

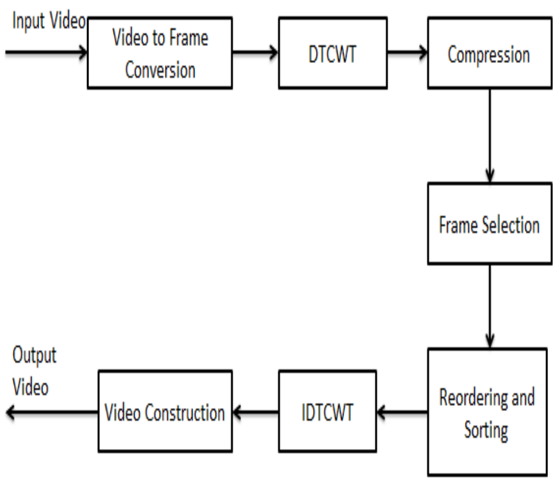
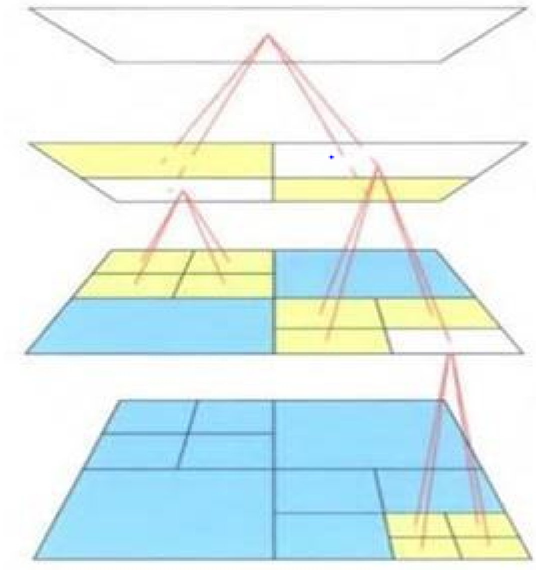


Figure.2 Block diagram of proposed system

B. Video Frame Compression

After the wavelet coefficients are decomposed by DTCWT, the frames are compressed by a method called Quad Tree based Fractal Image Compression. A fractal is a mathematical function that contains formulas and coefficients and can be used to produce colorful images with infinite levels of information. It represents high resolution image with a few thousand bytes of formulae and coefficients instead of multimegabyte file sizes. But identifying the correct set of formulas and coefficients is a real challenge. So an appropriate method called Quad Tree based Fractal Image Compression is Proposed here.



White- Uncovered Ranges
Yellow-Ranges covered in current level
Blue-Ranges covered in previous level

Figure.3 Quad Tree based Fractal Image Compression

Quad Tree based Fractal Image Compression maintains the image quality level and does the compression in a reasonable amount of time and it provides better compression ratio. It divides the images into 16 squares each called Range and 4 squares each called Domain [7]. It tries to map every range with a domain to reach maximum similarity. If it does not reach the threshold then each uncovered range is considered as an image and divided into four squares and the same process is continued. These processes are shown in figure 3.Further if the similarity is not reached then optimal fitness maps are used to map the range to the domain.

IV. IMPLEMENTATION RESULTS

Here for compressing HD video three HD video sample is taken. Initially the video is separated into frames and the frames are compressed using Quad Tree based Fractal Image Compression for reducing delay and to increase the compression ratio as well as efficiency based on similarity between the frames. Here the directional filters are used for implementing DTCWT and it reduced the processing memory and time and the results are shown below for the reduced compression time in table 1 along with input frame and compressed frame for the three video samples in figure 4.

Figure .4 Input and Compressed frames of three different video samples

The delay values for the three video samples using DWT through Arithmetic Coding and DTCWT through Quad Tree based Fractal Image Compression are given in table 1 along with PSNR values.

Table.1 Delay values using DWT and DTCWT with PSNR values

Video	Delay using DWT with Arithmetic Coding (seconds)	Delay using DTCWT with Quad Tree compression (seconds)	PSNR
Eagle	120.24	62.12	39.11
Waterfall	115.81	57.28	39.75
Mountain	122.41	58.43	38.97

V. CONCLUSIONS AND FUTURE SCOPE

Lossless embedded video compression based on DTCWT algorithm and Quad Tree based Fractal Image Compression is presented here. Here the frames are extracted from the input video sequence and compressed using Quad Tree based Fractal Image Compression by mapping ranges with domains. Then the frames are analysed to select only the required frames and to reject frames based on similarity. Thus delay taken for compressing video frames is also considerably reduced by using DTCWT with Quad Tree based Fractal Image Compression compared to DWT with Arithmetic Coding method and the quality of video is also unaffected. As a furure work another method using high performance filters can be implemented for further increasing the compression efficiency by reducing the compression time.

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