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Research Article

HIGH EFFICIENCY VIDEO COMPRESSION USING MULTIWAVELET BLOCK CODING

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ABSTRACT

Over the past decades, digital video compression technologies became associate degree integral part of the way we have a tendency to produce, communicate and consume visual data. Digital video communication is found nowadays in several application sceneries like broadcast services over satellite and terrestrial channels, digital video storage and transmission , wires and wireless colloquial services and etc. the information amount is extremely massive for the digital video and the memory of the storage devices and the information measure of the transmission channel are not infinite, thus it is not sensible for to save the full digital video while not process. as an example, if we have a 720 x 480 pixels per frame,30 frames per second, total ninety minutes full color video, then the complete information amount of this video is regarding 167.96 Giga bytes. Thus, many video compression algorithms had been developed to cut back the information amount and give the acceptable quality as attainable as will. This project starts with an evidence of the video compression mistreatment rippling and multiwavelet algorithms with SPIHT and block tree coding and video quality measures.

General Terms: Video compression, Multiwavelet, Block coding, SPIHT.

Keywords: Video coding, Video compression, Motion estimation, Video quality measurement.

INTRODUCTION

Video is a sequence of images called frame displayed at a certain rate (so many frames per second or fps) to create the illusion of animation and it have a huge amount of data. Digital video is the case where a (digital) camera generates a digital image, i.e., an image that consists of pixels. Many people may intuitively feel that an image produced in this way is inferior to an analog image. An analog image seems to have infinite resolution, whereas a digital image has a fixed, finite resolution that cannot be increased without loss of image quality. In practice, however, the high resolution of analog images is not an advantage, because we view them on a television screen or a computer monitor in certain, fixed resolution. Digital video, on the other hand, it has the important advantages such as it has easily edited, stored as a digital medium and it can be compressed to occupy low disk space[1,5].

NEED OF VIDEO COMPRESSION

An uncompressed video produces an enormous amount of data. For high definition video: 1920 x 1080 x 60 x 8 + 2 x (960 x 1080 x 60 x 8) = 1.99 Giga bytes are required. Even with powerful computer systems (storage, processor power, network bandwidth), such data amount cause extreme high computational demands for managing the data. luckily, digital video contain a great deal of redundancy. That is suitable for compression, which can solve these problems significantly. Video compression reduces storage requirements but also overall execution time, reduces the probability of transmission errors since fewer bits are transferred and it provides a level of security against illicit monitoring. Video compression is based on two principles. The first is the spatial redundancy that exists in each frame. The second is the fact that most of the time; a video frame is very similar to its immediate neighbors. This is called temporal redundancy[2-4]. A typical technique for video compression should therefore start by encoding the first frame using a still image compression method. It should encode each successive frame by identifying the differences between the frame and its predecessor and encoding these differences. If a frame is very different from its predecessor (as happens with the first frame of a shot), it should be coded independently of any other frame. In the video compression a frame that is coded using its predecessor is called inter frame (or just inter), while a frame that can coded independently is called intra frame (or just intra).

VIDEO COMPRESSION

Video Acquisition

Video is acquired through the use of a digital camera. The digital camera is more susceptible to noise, higher pixel resolution, the signal to noise ratio is typically higher and better accuracy. The sample video frame rate is 29 frames per second.

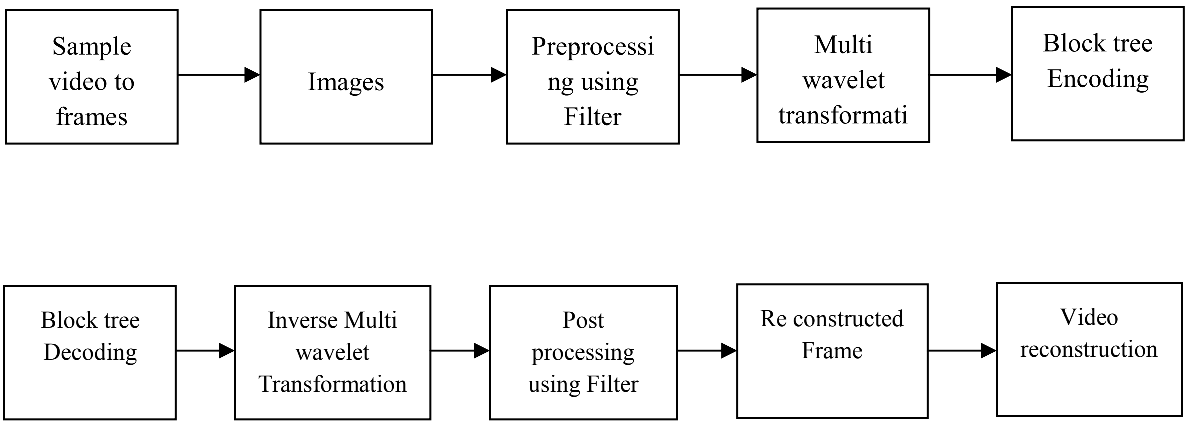

Figure 1: Video compression System Block Diagram

Pre-Processing

In this section The video is consisting of sequence of frames the frames are extracted from the video using the Baysian MAP estimation[7]. In the preprocessing stage the image is first converted into RGB to gray. It is the one of the simplest image enhancement techniques further enhance using histogram equalization and remove the noise using Gaussian filter. Histogram equalization is a method in image processing of contrast adjustment using the image's histogram. This method increases the global contrast of images, particularly when the usable data of the image is represented by close contrast values. Through in this adjustment, the intensities can better distribute on the histogram. It allows for areas of lower contrast to gain a higher contrast. Histogram equalization performs this by effectively spreading out the most frequent intensity values. The system is useful in images with foregrounds and backgrounds that are both are bright or dark. A main advantage of the method is that it is a fairly straightforward technique and an reverse operator. The Gaussian smoothing operator is a 2-D convolution operator that is used to `blur' the images and remove noise and small details . This sense it is similar to the mean filter, but it use a different kernel that represents the shape of a Gaussian (`bell-shaped') hump. In 2-D, an isotropic (i.e. circularly symmetric). The preprocessing output is shown in figure 2.

Figure 2: (a) Original Frame (b) Gray scale image (c) Gabor Filter Output (d) Histogram Equalization

2.3 Existing Method

The 'wavelet transform' that is popular in image compression is based on set of filters with coefficients that are equivalent to discrete wavelet functions[6,8]. The basic operation of the transform is applied to a discrete signal containing N samples. A pair of filters is applied to the signal to decompose it into a low frequency band (L) and a high frequency band (H). Each band is sub sampled by a factor of two, so that the two frequency bands each contain N/2 samples. With the correct choice of filters, this operation is reversible. This approach may be extended to apply to a 2-dimensional signal such as an intensity image. Each row of a 2D image is filtered with a low-pass and a high-pass filter (Lx and Hx) and the output of each filter is down-sampled by a factor of two to produce the intermediate images L and H. L are the original image low-pass filtered and down sampled in the x-direction and H is the original image high-pass filtered and down sampled in the x-direction. Next, each column of these new images is filtered with low- and high-pass filters Ly and Hy and down-sampled by a factor of two to produce four sub-images LL, LH, HL and HH. These four 'sub-band' images can be combined to create an output image with the same number of samples as the original. 'LL' is the original image, low-pass filtered in horizontal and vertical directions and sub sampled by a factor of two. 'HL' is high-pass filtered in the vertical direction and contains residual vertical frequencies, 'LH' is high-pass filtered in the horizontal direction and contains residual horizontal frequencies and 'HH' is high-pass filtered in both horizontal and vertical directions. Between them, the four sub-band images contain all of the information present in the original image but the sparse nature of the LH, HL and HH sub-bands makes them amenable to compression. Many of the samples (coefficients) in the higher-frequency sub-band images are close to zero, shown here as near-black, and it is possible to achieve compression by removing these insignificant coefficients' prior to transmission. At the decoder, the original image is reconstructed by repeated up-sampling, filtering and addition. The wavelet output shown in figure 2.

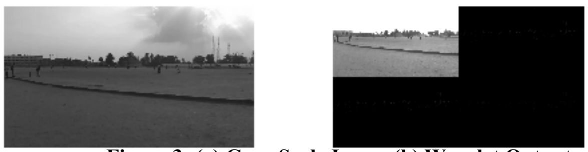

Figure 3: (a) Gray Scale Image (b) Wavelet Output

Proposed Method

The proposed Method is Multiwavelet Transform[9]. The term 'multi' means more than one. Multi-wavelets indicate more than one wavelet. Multiwavelets have two or more scaling and wavelet functions. Multiwavelets is defined using several wavelets with several scaling functions. Multiwavelets have more advantages than scalar wavelet. The features are symmetry, compact support; orthogonality and higher order approximation are known to be important in signal processing. A scalar wavelet can't possess all these properties at the same time. On the other side, a multiwavelet system can simultaneously provide perfect reconstruction while preserving length (orthogonality), good performance at the boundaries (via linear-phase symmetry) and a high order of approximation (vanishing moments). Thus multiwavelets gives the possibility of best performance and high degree of freedom for image processing applications, compared with scalar wavelets. When a multiresolution analysis is generated using multiple scaling functions and wavelet functions[10], it gives rise to the notion of multiwavelets .A multiwavelet with 'r' scaling functions and 'r'wavelet functions is said to have multiplicity 'r'.When r = 1, one scaling function and one wavelet function, the multiwavelet system lowers to the scalar wavelet system. Multiwavelets differ from scalar wavelet systems in requiring two or more input streams to the multiwavelet filter bank. Corresponding to each multiwavelet system, there is matrix-valued multirate filter bank. A multiwavelet filter bank has "taps" that are N×N matrices. The 4-coefficient symmetric Multiwavelet filter bank whose low pass filter is given by the four N×N matrices named as a C. Unlike a scalar 2- band Para unitary filter bank, the corresponding high pass filter(HPF) specified by the four N×N matrices named as a D, can't be obtain a simply as an alternating flip of the low pass filter(LPF); the wavelet filters D must be designed. The resulting N-channel, N×N matrix filter bank operates on N input data streams, filtering them into 2N output streams, each of which is down sampled by the factor of 2. This is shown in below Figure 3 .Each row of the multi-filter is a combination of N ordinary filters, each are operate on the separate data stream.

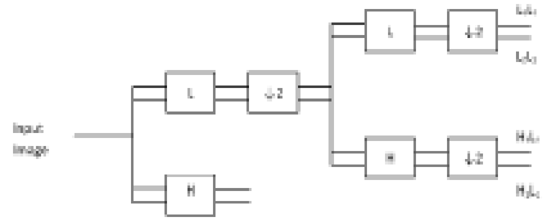

Figure 4: I -level Multiwavelet decomposition

The multiwavelet decomposition iterate on the low-pass coefficients from the previous decomposition. The multiwavelet decomposition is shown in figure 5.

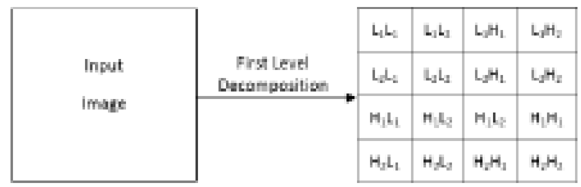

Figure 5: Representation of Multi Wavelet Decomposition of Input Image

SPIHT Algorithm

The SPIHT algorithm is a highly refined version of EZW algorithm[11]. It was designed and introduced by Said and Pearlman for still image compression. SPIHT represents a small "revolution" in image compression because it broke the trend to more complex (in both the theoretical and the computational senses) compression schemes. While researchers had been trying to improve previous schemes for image coding using very sophisticated vector quantization, SPIHT achieved superior results using the simplest method: uniform scalar quantization. Thus, it is much easier to design fast SPIHT codec. The SPIHT algorithm is nearly symmetric, i.e., the time to encode is nearly equal to the time to decode. The SPIHT method is not a simple extension of traditional methods for image compression, and represents an important advance in the field. The method deserves special attention because it provides good image quality, high PSNR, It is optimized for progressive image transmission, Produces a fully embedded coded file, Simple quantization algorithm, Fast coding/decoding, Has wide applications, completely adaptive, Can code to exact bit rate or distortion.

The SPIHT algorithm taking the advantage of the properties of the wavelet coefficients[12]. In wavelet coefficients, most of the energies are in the low frequency sub bands and there are coefficients in the different sub bands that correspond to the same spatial locations. These coefficients can form a tree link between them and they have parent – child relationship, with the root in the lowest sub band. Each node has four children and three for the coefficients in the lowest sub band. If the root has small magnitude, it is likely that the entire tree under it has small magnitudes. It is known as the zero trees. The parent – child relationship is shown in the Figure 6.

There are three lists maintained in SPIHT encoding. List of significant pixels (LSP), List of insignificant pixels (LIP), and List of insignificant sets (LIS).There are two passes, sorting pass and refinement pass. Sorting pass carry the encoded details and the refinement pass carry the correction terms. One pass of SPIHT sequence can be obtained by the following step of operations.

- For each entry in LIP
  - If L(i,j) >= 2^n ; send 1 and sign, move the coefficient to LSP
  - If L(I,j) < 2^n ; send 0
- For each entry (i,j) in LIS
  - If the set is type A
    - If the set D (i, j) is insignificant, send 0.
    - Otherwise send 1 and
    - Check each of the four offspring in O (i, j).
  - Significant : send 1 and sign, move to LSP
  - Insignificant : send 0, move to LIP
    - If L (i, j) is not empty, move (i, j) to the end of LIS as type B. Otherwise remove (i,j from LIS).
  - If the set is type B
    - If the set L (i, j) is insignificant, send 0.
    - Otherwise send 1 and
    - Add the four offspring in O(i,j) to the end of LIS as type A
    - Remove (i, j) from LIS.
- Refinement: For each entry in LSP, excluding those added in this pass
  - Send the n^{th} bit of the absolute value
- Reduce the threshold n=n-1, and move to the next pass

The output sequence from the SPIHT encoder has a three byte header which contains the number of pixels in the image, initial bit plane and maximum number of level of decomposition of the image. This information is helpful for the decoding of the sequence. The encoded coefficients can be exactly reconstructed from the encoded sequence by reverse operation.

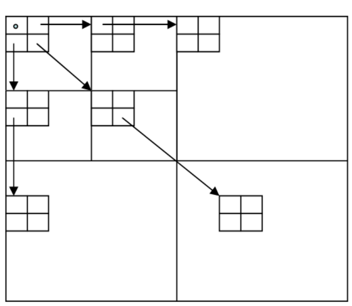

Figure 6: SPIHT Parent Child Relationship

Wavelet Block Tree Coding

Moinuddin et al , proposed WBTC for scalar wavelet decomposed images, which combines the features of both zero tree coding algorithm like SPIHT and zero block coding algorithm like Set Partitioning Embedded block (SPECK) to provide inter and intra sub band correlation. The WBTC overhands the SPIHT in three aspects: first it creates zero trees with more elements, second it strengthens the intra sub band correlation and thirdly it reduces the encoding time[13]. However its efficiency can be fully signified only when applied to multiwavelet transformed data. This motivates us to apply block tree coding to multiwavelet transformed image and for the first time applied this to Multiwavelet transformed image. The proposed MBTC algorithm partitions[8] the image transformed coefficients into coefficient blocks and then block trees are formed with the roots in the topmost sub band in a zero tree fashion. In a block tree, significant blocks are found using the tree partitioning concept of SPIHT, whereas significant coefficients within each block are found using the quad-tree partitioning of SPECK

Consider an image X of size MxN that after Nd levels of wavelet Transformation exhibits a pyramidal sub band structure. The transformed image is represented by an indexed set of transformed coefficients {Ci, j} located at i^{th} row and j^{th} column. The coefficients are grouped together in blocks of size mxn and the block trees are formed with roots in the topmost (LL) sub band. A block tree is a tree of all descendent blocks of a root block.

$$S_b(T) = \begin{cases} 1, max(\{|C_{i,j}|\} \geq 2^b, C_{i,j} \in T \\ 0, \quad Otherwise \end{cases}$$

Where set T may either be an individual block of mxn multiwavelet coefficients or SOT of a block. Like SPIHT, MBTC maintains three ordered lists.LIB (List of insignificant blocks) LIBS(List of insignificant block sets) LSP(List of significant pixels). The parent-child relation for the block coding is shown in figure 7.

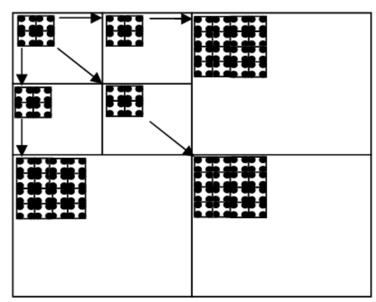

Figure 7: Wavelet Block tree coding.

The decompression side the reverse process using inverse blocks tree coding and inverse multiwavelet are used to reconstruct the video.

VIDEO QUALITY MEASUREMENT

Video quality is a characteristic of a video passed through a video transmission or processing system, a formal if not informal measure of perceived video degradation (typically, compared to the original video). Video processing system introduces some amounts of distortion or artifacts in the video signal, so video quality estimation is an important problem. Some quality measures are Mean square estimation and Peak signal to noise ratio. The MSE[14] is computed by averaging the squared intensity differences of the distorted and reference image or frame pixels. Two distorted images with the same MSE may have very different types of errors, some of are much more visible than others.

PSNR is a type of objective (algorithmic) quality measures[4,5]. The PSNR is most commonly used as a measure of quality of reconstruction of compression codec's. The signal in this case is the maximum value of the pixels and the noise is the error introduced by compression. PSNR can be calculated easily and quickly and is therefore a very popular quality measure.

CONCLUSION

The Main objective of this project is to compress the video sequence using multiwavelet with SPIHT and MW block tree coding. WBTC algorithm improves the compression performance of SPIHT at lower rates by efficiently encoding both inter and intra scale correlation requirement by using block trees. Though WBTC lower the memory requirement by using block trees compared to SPIHT.

FUTURE SCOPE

Video compression is used in current and emerging products. It is the heart of the digital television set top boxes, internet video, DVD players, video conferencing and other applications. these application benefits from the video compression in the fact that they may require smaller storage space for achieved video information and smaller bandwidth for the transmission of the video information from one point to another or a combination of the both. Besides the fact that it works well in a wide variety of applications.

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