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A MULTIPLE DESCRIPTION CODING METHOD BASED ON SET PARTITIONING IN HIERARCHICAL TREE ALGORITHM FOR HIGH DEFINITION IMAGE

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ABSTRACT

In this paper a new multiple description coding (MDC) method for High Definition (HD) image is presented. The proposed approach is based on the Set Partitioning In Hierarchical Tree (SPIHT) algorithm, which achieve a high image compression ratio. In this approach the coding is done by using SPIHT algorithm but the image is passes in different way. In this scheme first of all the original image is under go through the poly-phase sampling technique [1] to generate multiple descriptions to varying internet environments. After poly-phase sampling all the descriptions are passes through SPIHT algorithm but her all the descriptions are further divide into number of descriptions. It results in having a capability to conquer packet losses and remaining the reconstructed image with an acceptable quality. In order to preserve the progressive reconstruction properties for a HD image transmission the separate packets of LL band, which having more information as compare to other bands(property of SPIHT) for all the descriptions generated after poly-phase sampling. The proposed method is very helpful for transmission and storing of HD images. It can be resolve two main problems occurs, one for transmission in error environments and other, memory required for storing the data. The experimental results are given to illustrate the characteristics and verity the efficiency of the proposed method.

KEYWORDS: MDC, Poly-Phase Sampling, SPIHT, Wavelet Transform

INTRODUCTION

In recent years, in company with network fast growth, universal, and diversity, how to efficiently transmit multimedia via the internet and more data can be store becomes very important. The key factor is that, which coding method can be adopt to transmit the data in that media where the error rate is varying.

The data storing in an organization or in medical is also a problem i.e. more and more data can be transmit and store by a minimum cost of memory. Due to emerging demands of network applications, more memory required for transmitting and storing data, unstable network and data losses causes serious problems in transmission. This proposed method is simple and efficient, and has features of simplicity, efficiency and flexibility.

An image coding method which provides good performance under congested network environment is very essential. This paper has adopted an idea of MDC described in [1], but the difference is that, this is for HD images. In this paper all the descriptions are independently coded with the same and different data size in the coding processes. The data can be transmitted in more than one time by different processes. The flexibility of this method is that in this processes the forward error correction (FEC) scheme does not require as compare to other. In [6], it shows that if the descriptions of image will increase, it shows the characteristics of the progressive reconstruction for the MDC.

In the traditional MDC we can say that if the number of descriptions received is higher, the quality of image will improved. It can perfectly reconstruct the original image when all the descriptions are received. The modified MDC has flexible numbers of descriptions for adapting package losses. These are features of MDC.

There are number of data compression algorithms based on wavelet transform, embedded zerotree wavelet (EZW), embedded block coding with optimized truncation (EBCOT), and set partitioning in hierarchical trees (SPIHT)[5][6] are three popular schemes. In these three schemes the SPIHT is the subject who has been discussed the most in the literature due to its simplicity, efficiency and high compression performance. The most efficient feature of SPIHT is that the ordering of the bit streams from more significant to less significant. In this the front part of the bit stream is more important than the rear part and it is transmitted first. The decoder receives and decodes the significant (front) data first. Therefore, when congestion occurs, keeping the front part of the bit streams can retain the important data. That is why it can improve and gives the better transmission performance under the unstable network where the congestion occurred or error rate is high. These are the reasons by which the SPIHT is mostly used as compare to other and it has the higher capability to contend against package lasses.

In this paper, taking advantage of high compression ratio and tolerance with package losses of the SPIHT algorithm, a new MDC method is developed. This new approach not only has better result in quality of construction image at low bit rate but also provides a very flexible and convenient frame work to have an arbitrary number of descriptions which tackle the limitation of having less number of descriptions in the existing MDC schemes [7][3] and process these descriptions in different stages of coder. This proposed method gives a good quality image of gray-level images.

RELATED WORK

Multiple Description Coding

Traditionally, multiple description coding (MDC) generates two equally significant descriptions and delivers in two different channels. It is an technique to create diversity and consequently enhance the reliability of communication systems to meet the challenge. Recently MDC has gained much popularity as an effective tool to cope with transmission errors when compressed media contents are delivered via error-prone channels or networks. It guarantees that the MDC reaches an acceptable quality when it receives one description only; as long as two descriptions don't lost simultaneously. MDC can generate more than two descriptions via a specific coding scheme. In that case, it will be more robust to lose one description. This means that a MDC scheme with more descriptions can tolerate with the loss of packages in the transmission. A MDC scheme does not require retransmission when package losses occur unless the losing rate is extremely high. That is why the MDC is so popular. Usually MDC is used for two applications: .real time communications and reducing the complex of network design. For real time communications, such as video phone or video conference, retransmission is not allowed in those applications. MDC doesn't need feedback and retransmission, and all the packages are equal. Fig. 1 shows the performance of MDC and other coding methods under the same losing rate. It is obvious that the MDC method performs much better than Layered and Non-layered coding methods.

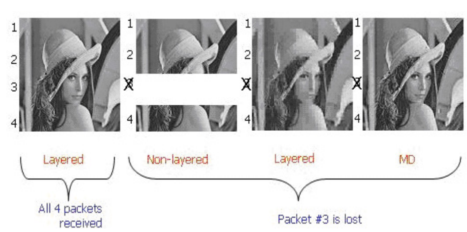


Figure 1: Comparisons of MDC and other Coding Methods [9]

Poly-Phase Sampling Technique

Poly-phase sampling is an image transformation which transforms one image into four-based images, such as 1 to 4, 1 to 16 and so forth. The example shown in Fig. 2 is to transfer one image into four images. Here, we take four pixels as a set, and mark them number1 to number 4, respectively on every specific position and placing the pixels together which have the same number in the same frames. [1]

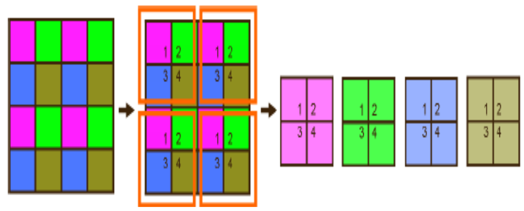


Figure 2: Four Pictures after Poly-Phase Sampling [1]

Set Partitioning in Hierarchical Trees

Set partitioning in hierarchical trees (SPIHT) is an image compressing algorithm. The image passes through discrete wavelet transform to generate a spatial orientation tree; the tree then passes through the quantization with sorting pass and refinement pass [8]. The result after the quantization is a coded bit stream. The processes are shown in Figure 4.

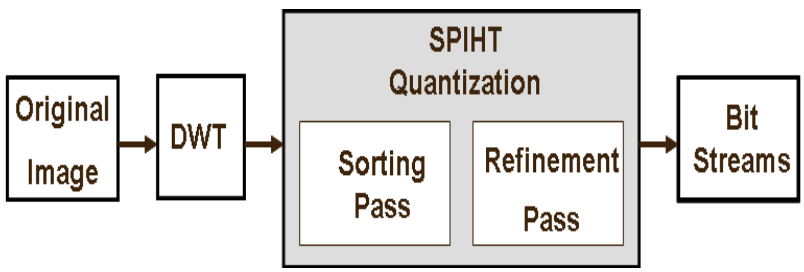


Figure 3: The Coding Process of SPIHT

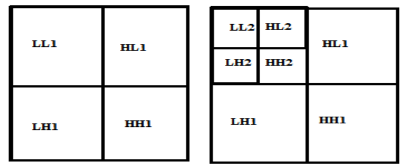
Wavelet Transform

An original image decomposes into a hierarchy after multi-resolution wavelet transform containing one lowest resolution low-pass sub-image on the top layer and three high-pass sub-images on each layer. As we know that human visual system is more sensitive to low frequency components than to high frequency components. In a wavelet transform (as shown in fig.4) we call HL1, LH1, and HH1 the sub-bands resulting from the first level of the image decomposition, corresponding to horizontal, vertical and diagonal frequencies [3].

The rest of the transform is computed with a recursive wavelet decomposition on the remaining low frequency sub-bands, until a desired decomposition level (N) is achieved (LLN is the remaining low frequency sub-band), Wavelet transform decorrelates the image, but there still exists cross-correlation between different layers for the same orientation high-pass sub-images.

It is noticed that the same orientation sub-images on different layers have a similar structure. Although such dependency between different resolutions has been used earlier to compress images such as EZW and SPIHT etc. which are based on wavelet trees structure, The LTW enhances the performance significantly.

Furthermore, the probability density function of wavelet coefficients is approximately a generalized Gaussian distribution. It is symmetric and has a peak value centered at zero. This implies that most of the coefficients will be around zero value and considered insignificant. A simple threshold can discard these insignificant coefficients and substantially reduce the computational complexity. The magnitude of wavelet [4][5].



(a) One-Level (b) Two-Level

Figure 4: Image Decomposition by Using DWT

PROPOSED METHOD

MDC has been studied as an approach for transmission of images over error prone environments. The MDC method for High Definition (HD) images proposed here takes into account the content of the image and provides the least amount of degradation, caused by loss of descriptors, for those areas of the images which are of greater interest. There are also some important issue such as coding efficiency, processing memory, coding complexity, bit rate scalability and error resistance.

The proposed research aims to develop an approach for MDC of HD images which improve the above mention issue related to it by using SPIHT wavelet based image compression algorithm. Fig. 4 shows the encoding block diagram of the proposed method. Firstly, we divide a HD image into four descriptions by using poly-phase sampling. Then each of them passes through the SPIHT algorithm in different ways as shown in fig. 4. After the poly-phase sampling, all the descriptions passes through SPIHT as LL band of all description named as D_{1LL} to D_{4LL} and the entire horizontal, vertical and diagonal tree as a separate descriptions as D_{1H} to D_{4H}, D_{1V} to D_{4V} and D_{1D} to D_{4D} respectively.

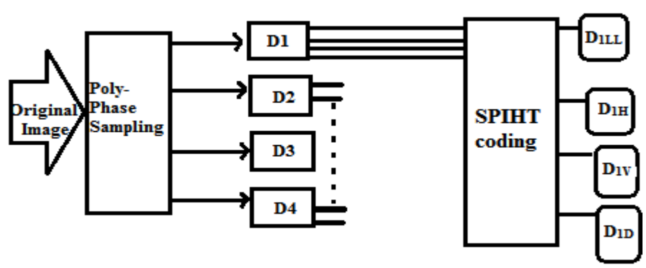


Figure 5: The Block Diagram of Proposed Method for Encoding

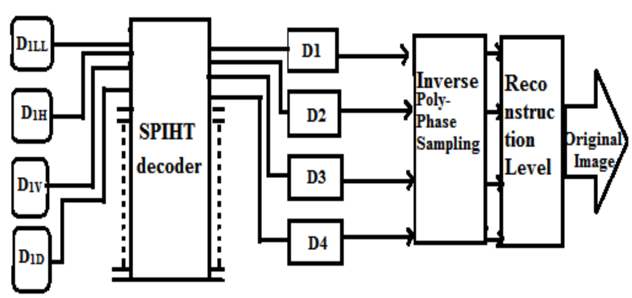


Figure 6: The Block Diagram of Proposed Method for Decoding

Figure 6 shows the decoding block diagram of the proposed method. After receiving the descriptions as LL band of all description named as D_{1LL} to D_{4LL} and the entire horizontal, vertical and diagonal tree as a separate descriptions as D_{1H} to D_{4H}, D_{1V} to D_{4V} and D_{1D} to D_{4D}, the first step is to pass them through the SPIHT decoder and then passes through the inverse poly-phase sampling as shown in fig.6. The last step is to perform reconstruction, to fill in the lost information caused by package losses and to reconstruct the original image. The original image will be obtained as same quality level if sufficient descriptions will obtain correctly.

Reconstruction

Reconstruction is the last step of decoding side to fill up the losing pixels caused by package losses. Take Fig. 7 as an example; assume that the brown pixel is the losing pixel. Reconstruction is obtained by taking average of 3 above pixels and filling in the losing pixel. This is a simple but an effective method.

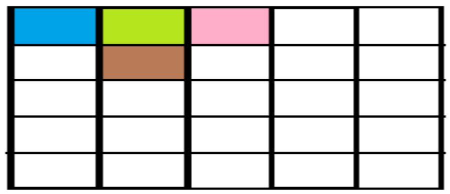


Figure 7: Reconstruction Block Diagram

Experimental Results

In this section, we show the experimental results of the proposed method. Experiments were conducted on standard images: the 512*512 "*Lena*" which is monochrome pictures with 8bpp (bits per pixel) before compression. The image, 5 levels of wavelet transform were performed with 0.5 bpp and a total of (16*n_max) packets are formed. The characteristics of the proposed method will be illustrated using the tested image Lena as shown in Fig.8. Results are obtained with the above said images and are tabulated as shown in table 1 and table 2. Results are averaged for 40 independent channel conditions i.e. for each BER, experiment is repeated 40 times and average PSNR is recorded.

LENA		
	Pr-SPIHT	SPIHT
BER	PSNR	PSNR
0	30.8598	36.5138
0.00001	28.1524	33.6867
0.0001	21.6067	22.6328
0.001	17.0245	16.3208
0.01	13.7589	12.1495
0.1	11.1035	7.9025

Table (i): PSNR (dB) at Different BER for LENA

Figure 8: Images Displayed here Show the Visual Effects of Loss for the SPIHT Coder (lower) vs. the Original SPIHT (upper). At (a) BER 0.00001 (b)BER 0.0001 (c) BER 0.001 (d) BER 0.01

The graph of PSNR versus BER has been drawn with the help of data in the table 1 for LENA image and is shown below in fig. 9, which clearly shows the improvement in the PSNR for Proposed SPIHT as compared to SPIHT for the same BER.

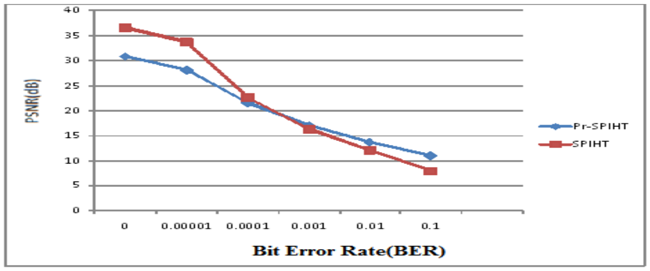


Figure 9: PSNR Versus BER Comparisons of SPIHT and Proposed-SPIHT for LENA

CONCLUSIONS

In this paper, we have showed that the proposed SPIHT algorithm has improved error resiliency performance as compared to standard SPIHT. Simulation results clearly reveal this claim. The graph of PSNR versus BER in Fig. 9 clearly shows an improvement in PSNR up to few dB for the lena image. This feature has been obtain due to the packetization of spatial orientation wavelet coefficients and subsequently the use of headers, which facilitates any error to be concealed within the coefficients grouped in the packet, thereby localizing the effect of noise in a portion of image only. In this paper we mostly concentrate on the packet formation. Here the information is transmitted in the form of packets and all the packets are contains header by which we can identify no. of bits and if any error occurred in the packet then it will discarded. It gives the advantage the error does not occur in the next data. Here also we see that the processing time is decreases as compare to the original SPIHT algorithm.

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