Review on Multiple Descriptive Coding (MDC) for the Set Partitioning Embedded Block (SPECK) Coder for Real Time Applications of Image Transmission over Wireless Channel

Santosh Kr. Mishra[1], Saif Ahmad[2], Dr. Rabindra Kumar Singh[3], Mohd Javed Khan[4]
[1, 2, 4] Department of Electronics & Communication Engineering
[3] Department of Electronics Engineering
[1, 2, 4] Integral University, Lucknow, Uttar Pradesh, INDIA
[3] KNIT, Sultanpur, Uttar Pradesh, INDIA

Abstract- *The reliable transmission of images and video over wireless channel poses many challenges due to packet losses caused by congestion in the internet and competing traffic, fading, interference. Multiple Descriptive Coding (MDC) may be the effective method for the transmission such multimedia information over wireless channels. In this methods the information may be protected up to some extend. The MDC scheme is useful in real time applications (where retransmission is not allowed) such as video phone or video conference. In noisy channel/error porn wireless channel MDC provides better method to receive acceptable quality of images or video at receiver side on handheld multimedia devices. where packet losses are high. Since in real time application. The objective of multiple descriptive coding MDC is to encode two or more than two bit stream. The high quality reconstruction can be achieved as more number of packets are received. A acceptable quality of reconstruction may occur with few received bit stream (packet).Here we have assumed that decoder will follow different algorithm when few packets are lost.*

Keywords- Multiple descriptive coding (MDC), set partitioning embedded block (SPECK) coder, memory efficient image coder.

I. INTRODUCTION

A communication system is designed to transmit information reliably. In wireless communication systems, due to packet loss and channel failures, reliable communication is a proven challenge. Multiple Description coding (MDC) might be an effective method to enhance the reliability of the wireless communication system to meet the challenges in present scenario. In this method, multiple but equally important descriptions of the source is produced and transmitted over different channels simultaneously, the various reconstruction qualities may be generated from different subsets of descriptions at receiver end . If only few descriptions are received the acceptable quality may be reconstructed .The quality of the reconstructed image will be improved as more number of descriptions are received. MDC can be divided into two important classes, Bandwidth-Efficient and Non-Bandwidth-Efficient methods. Inherent redundancy property of the image is used in Bandwidth-efficient MD encoders i.e. no extra bits (redundancy) are introduced between descriptions. Since, the inherent redundancy makes the bit stream robust and enables the estimation of the lost descriptions from the received descriptions. The different descriptions can be generated by partitioning the image before or after the transform. Non-bandwidth efficient MD encoders introduce A extra controlled redundancy bits are added which is not inherent in the signal, between descriptions in different ways in Non- bandwidth efficient MD encoders.

II. RELATED WORK

1. Bandwidth-efficient MDC:

(a) A new low complexity and efficient multiple description image encoder for wireless applications [1]: The method presented in this paper is bandwidth-efficient multiple descriptive encoder method is used. Since the bandwidth-efficient multiple descriptive encoder methods require lesser bandwidth than non bandwidth-efficient encoder which is not much suitable for wireless channels. In bandwidth-efficient MD encoders extra redundancy bits are not introduced for the different descriptions, it uses inherent redundancy of the signal to create the multiple descriptions. So, the bandwidth-efficient methods with low complexity and high efficiency are appropriate approach. In spite of above advantages this method requires lot of static memory for encoding of multiple descriptions which is not suitable for handheld/portable devices. This research work does not propose any method to reduce to minimize the memory requirement during the encoding of different descriptions. The proposed method integrates Poly-phase Sampling, SPIHT, Interleave, Merging and Splitting, and the Reconstruction techniques to meet the challenges such as package losses, congestion, and paper has high compress performance. The proposed technique quit suitable for colour image transfer over wireless channels. Another characteristic of the method is that it can adjust the numbers of descriptions as users' expectation. This means that we can transmit more descriptions to high resolution devices, and fewer descriptions to low resolution devices. These features of the proposed method provide flexible designs and practical applications for various network environments, and remain an acceptable quality when packet loss occurs.

The proposed algorithm is suitable for the reliable transfer of colour images over error prone wireless channels. But paper concentrates on the multiple descriptive coding so that the high quality or acceptable quality of reception of the colour images through wireless channels. Since the SPIHT coder is used to compress the data which are scalable, embedded but requires memory for coding. This required static memory which is constrained for handheld devices.

(c). Multiple descriptive coding is generated by using pair wise correlating transform (PCT)[3-6]

The method presented in this paper is the adaptive down-sampling based on wavelet. Earlier used method has poor performance when PTC was used on the low-frequency coefficients. Here the scheme is not only to get the basic descriptions by applying PCT on the low-frequency wavelet coefficients [4] , the adaptive down-sampling on the high-frequency wavelet coefficients of the highest-level decomposition to get two groups, whose coefficients can be the roots of spatial orientation trees according to the Set Partitioning in Hierarchical Trees (SPIHT) [5],so that we can get the enhanced descriptions and also to get the groups .Although the side decoder can easily estimate one basic description from another with the controlled correlation when failure occurred during transmission, it is difficult to estimate one enhanced description from another using the conventional interpolation algorithm due to the feature of spatial orientation tree. To overcome this difficulty, we adopt the Wavelet Domain Interpolation for tree Reconstruction (WDIR) to conceal coefficients loss in Wavelet-Trees when one enhanced description lost during transmission. Similar ideas of WDIR have also been proven to be successful in wavelet domain in [6].

The method discuss is quite suitable for Image and Video over wireless channels by using multiple descriptive coding. But in this method the researcher used SPIHT coding technique after wavelet transformation to achieve data compression before transmission. As we know that the memory is one of the limitation for handheld/portable devices, So, the presented method will not be suitable for real time applications (e.g. video conferencing) with .

2. Non Bandwidth-efficient MDC:

A central issue in practical MDC designs is how to introduce a controlled amount of redundancy into the descriptions which the decoder can conveniently utilize, and many methods have been proposed. A multiple description scalar quantizer (MDSQ)[7] is developed by using a central quantizer and an index assignment, which generates two side quantizers such that each of them alone produces an acceptable side distortion, whereas their combination yields the finer central quantizer. The MDSQ is asymptotically near optimal [8], and has been employed in [9-10], after the DCT or wavelet transform. However, the MDSQ index assignment is difficult to design and implement, and its redundancy is not easy to adjust. A modified MDSQ (MMDSQ) [11] with the same asymptotical performance as the MDSQ is developed, in which two staggered scalar quantizers are used to generate the first layer of each description. Another scalar quantizer is used to further partition the joint bins of the first-layer quantizers, and its output is split into the two descriptions. The MMDSQ avoids the index assignment and can easily adjust the redundancy. It also outperforms other MDSQ-based methods in MD image coding.

However, both MDSQ and MMDSQ do not perform well at low redundancy regime, which is a desired property of good MDC schemes [12, pp. 365] & controlled amount of redundancy is introduced to generate multiple descriptive coding which is not bandwidth efficient code.

3. Other Related Work:

Another family of MDC schemes is based on the source splitting approach pioneered by Jayant [13-14], where a signal is split into even and odd samples, and DPCM is used to encoded each description. If one description is lost, the missing data are predicted from their neighbors in the other description, using the source correlation. However, the prediction errors of the missing data are tied to the source correlation, which cannot be controlled. DPCM[15] is used before splitting, and the prediction in the DPCM is designed to preserve some source correlations. Therefore, the redundancy between the descriptions can be adjusted to some extent. Although the method reduces rates .the inter description prediction error, the remaining error still limits the side decoder performance, especially at high

In [16], the transform coefficients are split into two parts. Each part is quantized into one description. To introduce redundancy, each description also includes a coarsely quantized version of the other part, which helps the decoding when the other description is lost. The optimal redundancy rate allocation is studied. A similar approach is developed in [17] using the SPIHT algorithm. Recently, this method is applied to the JPEG 2000 framework in [18] under the name of RD-MDC, in which each JPEG 2000 code-block is encoded at two rates, one in each description, to get balanced descriptions and optimal performance, the RD-MDC needs to classify all code-blocks into two subsets, such that any code-block in one subset has similar characteristics to another code-block in the other subset. This procedure is quite time-consuming. In addition, the side distortion of the RD-MDC at low redundancies is not satisfactory. The pair wise correlating transform (PCT) [12] represents another method of introducing redundancy, where a set of 2 correlating transforms is applied to the uncorrelated coefficients after the DCT. The outputs of each PCT are split into two descriptions. If one coefficient is lost, it is estimated from its counter part in the other description. The PCT framework has some inherent drawbacks. First of all, although the PCT has good low redundancy performance in theory, its practical application could not fully achieve this, because the PCT can only be applied to coefficients with large variances relative to the quantization error [12]. Other coefficients are directly split into the two descriptions. In the side decoder, these low-variance coefficients are simply estimated as zero, which limits the side decoder performance at low redundancies. Second, similar to [13], the PCT does not perform well at high redundancies because of the prediction residual [19].

As a summary, the methods in [7,10-12], and [16-20] offer good redundancy control, but do not fully exploit the source correlation. Although the schemes in [13] and [14] can achieve good performance at low redundancies by utilizing the source correlation, they cannot adjust the redundancy of the MDC system. The algorithm in [15] uses the source correlation to adjust the redundancy, but suffers from the prediction error. The method used in [21-26] are sacrifice too much coding efficiency to get good error resilience, and they all suffer from the prediction residual at high rates. In addition, they have to change the transform to adjust the redundancy, which is not convenient in practice.

The methods in [1-26] presented are quite effective for the transmission of images and videos over wireless channels where retransmission is not allowed, with multiple descriptive coding scheme. In all the research papers the Multiple Descriptive data (MDC) compression technique has been proposed these are quite suitable for transmission over erroneous environment. Such type of the data compression technique is also suitable where data losses due to congestion in the internet and competing traffic, fading, interference and mobility in the wireless networks .The different methods are adopted nearly in all the research papers to create two or more than two co-related descriptions which are essential for the MDC.

Due to rapid growth in handheld / portable devices in present scenario a lot of data, we have to transmit over wireless channels where retransmission is not allowed (like video conferencing), in that case MDC might be the one solution. But in present situation (i.e. in handheld devices case were the static memory, battery power, processing power are the main issues) above research method are not suitable because they requires more static memory (because coder like SPIHT & SPECK requires few static memory, while LTW coder does not require any dynamic memory but this is not scalable & embedded).

III. PROPOSED METHOD

3.1 Multiple Description Coding

Traditionally, multiple description coding (MDC) generates two equally significant descriptions and delivers in two different channels. It is a 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. It is obvious that the MDC method performs much better than Layered and Non- layered coding methods

The methods proposed above is not much suitable in present scenario i.e. image /video transmission through wireless channels over handheld/ portable device. Since in real time application where retransmission is not allowed the MDC is better option. But the communication related with handheld/ mobile devices have limitations. Like power backup, processing complexity and memory which are not well considered in above presented methods so they are not well suitable such applications. Since we are living in era of Internet i.e. we sharing lot of information between different locations not only over computers but over portable /hand held devices like mobile phones. So for the proper transmission and reception of images/ videos over handheld devices the MDC method must consider the constrained associated with hand held devices in present scenario. Since in multiple descriptive coding multiple bit streams are generated and transmitted over different channels. If all the bit streams are received good quality of the picture is decoded and if few streams are received at least acceptable quality of picture can be constructed and the quality will be improved as more number of description are received.

3.2 Poly-phase 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. 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. [2]

3.3 Proposed Method

After generating above four samples for a single image then each of them passes through the SPECK algorithm in different ways . After the poly-phase sampling, all the descriptions passes through SPECK 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.

3.4 Reconstruction

Reconstruction is the last step of decoding side to fill up the losing pixels caused by package losses. 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.

3.5 Simulation Results

Table 1: PSNR (dB) at Different BER for LENA

LENA		
BER	SPECK (proposed)	SPECK
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

3.6 Performance and Drawbacks

The proposed SPECK algorithm has improved error resiliency performance as compared to standard SPECK at higher bit error rate (BER) which is suitable for our error prone wireless channels. Simulation results clearly reveal this claim. 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 method 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 we see that the processing time and the dynamic memory requirement are decreased, as compare to the original SPECK algorithm. .

IV. CONCULSIONS

In this proposed method I have consider that header content will not be effected by the noise or their will no loss of data content of header during the transmission which will not be true in all cases . If any loss of information in header data which is essential for the proper reconstruction of image from the received packets, the proper reconstruction of image is not possible even all the packets all received. So, I have to modify this proposed method to rectify this drawback. In-spite of this the simulation result also shows that the proposed method is more suitable for higher bit error rate BER.

In real time applications such as video conferencing or image transmissions in present scenario it is required to develop an efficient method to transmit for handheld devices. MDC might be the one of the solution to over come the problem of packet loss due to the congestion in traffic or due to the erroneous environment of wireless channels. And also I have consider the constrained with hand held/ portable multi media devices like processing power, power backup and memory capacity problem. So to save the memory liner indexing method based SPECK coder must be implemented which does not require static memory that is more suitable for real time applications through wireless channels over portable devices.

REFERENCES

[1] Mehdi Malboubi, Ahmad Bahai, and Mustafa ;"Multiple Description Image Coding: A New Efficient and Low Complexity Approach for Wireless Applications" Department of EECS University of California Berkeley mehdi_malboubi@yahoo.com, {bahai, ergen} @eecs.berkeley.edu

[2] Chin-Pan Huang, Bor-Jiunn Hwang, Chia-I Mao, Wei-Chuan Wang "A Multiple Description Coding Method Based on Set Partitioning in Hierarchical Trees Algorithm for colour Images" Proceedings of the Eighth International Conference on Machine Learning and Cybernetics, Baoding, 12-15 July 2009

[3] Zhidu and Tailong LU" An Efficient Multiple-Description Image Coding on Wavelet" 2009 IEEE

[4] J. Liu and Y. Yu, "Research on multiple descriptions transform coding algorithm based on wavelet," Computer Application, vol. 25, no. 2, pp. 317-319, 2005.

[5] Amir Said and William A. Pearlman, "A new, fast, and efficient image codec based on set partitioning in hierarchical trees," IEEE Trans.On Circuits and System for Video Technology, vol. 6, no. 3, pp. 243-249, 1996.

[6] G. Ma, B. Guo, and Z. Feng. "An approach of wavelet domain interpolation for image reconstruction in transmission," ACTA ELECTRONICA SINICA, vol. 30, no. 4, pp. 552-555, 2002 .

[7] Guoqian Sun, Upul Samarawickrama, Jie Liang, Chao Tian, Chengjie Tu,"Multiple Description Coding With Prediction Compensation' IEEE Transaction on Image Processing, VOL. 18, NO. 5, MAY 2009.

[8] V. A. Vaishampayan, "Design of multiple description scalar quantizers, "IEEE Trans. Inf. Theory, vol. 39, no. 3, pp. 821–834, May 1993.

[9] V. A. Vaishampayan and J.-C. Batllo, "Asymptotic analysis of multiple description quantizers", IEEE Trans. Inf. Theory, vol. 44, no. 1, pp.278–284, Jan. 1998.

[10] J.-C. Batllo and V. A. Vaishampayan, "Asymptotic performance of multiple description transform Codes", IEEE Trans. Inf. Theory, vol. 43, no. 2, pp. 703–707, Mar. 1997.

[11] S. D. Servetto, K. Ramchandran, V. A.Vaishampayan, and K.Nahrstedt, "Multiple description wavelet based image coding," IEEE Trans. Image Process., vol. 9, no. 5, pp. 813–826, May 2000.

[12] C. Tian and S. S. Hemami, "A new class of multiple description scalar quantizer and its application to image coding," IEEE Signal Process. Lett., vol. 12, no. 4, pp. 329–332, Apr. 2005.

[13] Y. Wang, M. T. Orchard, V. A. Vaishampayan, and A. R. Reibman, "Multiple description coding using pairwise correlating transforms," IEEE Trans. Image Process., vol. 10, no. 3, pp. 351– 366, Mar. 2001.

[14] N. S. Jayant, "Subsampling of a DPCM speech channel to provide two self-contained half-rate channels," Bell Syst. Tech. J., vol. 60, pp. 501–509, Apr. 1981.

[15] N. S. Jayant and S. W. Christensen, "Effects of packet losses in waveform coded speech and improvements due to an odd-even sample-interpolation procedure," IEEE Trans. Commun., vol. COM-29, no. 2, pp. 101–109, Feb. 1981.

[16] A. Ingle and V. A. Vaishampayan, "DPCM system design for diversity systems with applications to packetized speech," IEEE Trans. Speech Audio Process., vol. 3, no. 1, pp. 48–58, Jan. 1995.

[17] W. Jiang and A. Ortega, "Multiple description coding via polyphase transform and selective quantization," in Proc. SPIE Conf. Visual Communication Image Processing, Feb. 1999, vol. 3653, pp. 998–1008.

[18] A. C. Miguel, A. E. Mohr, and E. A. Riskin, "SPIHT for generalized multiple description coding," in Proc. IEEE Conf. Image Processing, Oct. 1999, vol. 3, pp. 842–846.

[19] T. Tillo, M. Grangetto, and G. Olmo, "Multiple description image coding based on lagrangian rate allocation," IEEE Trans. Image Process., vol. 16, no. 3, pp. 673–683, Mar. 2007.

[20] Y. Wang, A. R. Reibman, M. T. Orchard, and H. Jafarkhani, “An improvement to multiple description transform coding,” IEEE Trans. Signal Process., vol. 50, no. 11, pp. 2843–2854, No. 2002.

[21] H. S. Malvar, Signal Processing With Lapped Transforms. Norwood, MA: Artech House, 1992.

[22] S. S. Hemami, “Reconstruction-optimized lapped transforms for robust image transmission, ” IEEE Trans. Circuits Syst. Video Technol., vol. 6, no. 2, pp. 168–181, Apr. 1996.

[23] D. Chung and Y. Wang, “Lapped orthogonal transform designed for error resilient image coding, ” IEEE Trans. Circuits Syst. Video Technol., vol. 12, no. 9, pp. 752–764, Sep. 2002.

[24] C. Tu, T. D. Tran, and J. Liang, “Error resilient pre-/post-filtering for DCT-based block coding Systems”, IEEE Trans. Image Process., vol. 15, no. 1, pp. 30–39, Jan. 2006.

[25] T. D. Tran, J. Liang, and C. Tu, “Lapped transform via time-domain pre- and post-processing, ” IEEE Trans. Signal Process., vol. 51, no. 6, pp. 1557–1571, Jun. 2003.

[26] J. Liang, C. Tu, L. Gan, T. D. Tran, and K.-K. Ma, “Wiener filter-based error resilient time domain lapped transform,” IEEE Trans. Image Process., vol. 16, no. 2, pp. 428–441 Feb. 2007

[27] V. K Goyal, “Multiple Description Coding: Compression Meets the Network,“ IEEE Signal Processing Mag., vol. 18, no. 5, pp. 74-93, Sept. 2001.