Progressive Source Channel Embedded Coding of Image Over Static (Memory Less) Channel

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Abstract

In this paper, we proposed a progressive time varying source channel coding system for transmitting image over wireless channels. Transmission of compressed image data over noisy channel is an important problem and has been investigated in a variety of scenarios. the core results obtained by a systematic method of instantaneous rate allocation between the progressive source coder and progressive channel coder .It is developed by closed form of expression for end-to-end distortion , rate allocation respectively in static channels. It is extended the static result to an algorithm for fading channels. It is introduced set DCT (blocks) approach is adapted to perform sub band decomposition followed by SPIHT (Set partitioning in Hierarchical tree)

Keywords: *Progressive source –channel coding, HC-RIOT, SPIHT*

1. Introduction

Progressive transmission is very useful in digital image transmission, in particular in the internet system and application in non homogeneous networks. Many of power wavelet coding algorithm having this property [1,2,3]. However progressive transmission is difficult to deal with transmission in a presence of noisy channel. Progressive coder use adaptive form of variable length coding, where the meaning of subsequent bit depends on decoding of previous bits. This information preserved in various states of the encoder and decoder .Even single bit error change the value of states with high probability, and decoded image will diverge sharply from the original. Thus high quality channel are needed to transmit such coded data various methods have been suggested in a literature to combat channel noise via error control coding for image transmission system [4, 5]. It is developed time varying progressive source channel coding techniques. It is derive general results of instantaneous code rate assignment for static channel through an analysis of the local importance of the source code bits as well as error propagation effects. This analysis is general and can be applied to any error correction codes and recursive source coders. Based on this analysis, we report a combined source channel coding scheme using rate compatible punctured convolution (RCPC) codes. In result of static channels, focuses on time in variant scheme, while our method is generalized to time varying as well as time invariant channel. It can be extended of static result to fading channels. we use one particular model for fading channel as shown Figure 1 our rate allocation scheme for fading channels assume no channel states information is available at the encoder or decoder. Our result show that for most fading channels, the optimal strategy is to target the design at the bad states of the channel.

2. Problem Formulation

We use the output of a progressive source coder as the input data stream into proposed algorithm. Input stream is divided into some blocks. Each block is supplemented with a cycle redundancy check (CRC) error control coding .the error detection code assure that the decoder will know if an unrecoverable error occurs, and will in the event stop decoding

Assume static binary symmetric channel (BSC). Cross over probability or bit –error rate (BER) of the BSC is denoted by φ , and P_n is the probability that block n after decoding, that is P_n is the probability that block n is not recovered correctly at the decoder. The partials distortion due to successful decoding of all blocks prior to n be denoted by d_n . The total end to end distortion of the system is denoted by D . l_n is the length of packet n subsequent to channel coding.

Total length can be written in term of probabilities of error free decoding up block n , which means there is no error in the blocks one through n .and there is an error in block $n+1$. This probability is equal to

$$P_n + 1\prod_{m=1}^{N}(1-P_m) \quad (1)$$

According to system that the first and last block need special treatment, the total distortion for static channel is

$$D = d_0 P_1 + \sum_{n=1}^{N-1} d_n P_{n+1} \prod_{m=1}^{n}(1-P_m) + d_N \prod_{m=1}^{N}(1-P_m), \quad (2)$$

where N is total number of channel blocks. to minimize the distortion according to the total channel transmission rate[6].

$$K_{(lm),N} = d_0 P_1 + \sum_{n=1}^{N-1} d_n P_{n+1} \prod_{m=1}^{n}(1-P_m) + d_N \prod_{m=1}^{N}(1-P_m). \quad (3)$$

Where, d_n are given through the rate distortion curves of the source code.

$$\sum_{n=1}^{N} l_n = L \quad (4)$$

L is the total number of bits available, to be divided in to source coder and channel coder. The optimization problem is over N and l_m . N Determines the tradeoff between the source coding bits and l_m determines the how the total available channel protection is given to over different blocks. After solving equation (4), it can be written as l_m in terms of P_n , the probability of block error. It can be approximately a log affine function, according block error rate under different channel code rate while channel BER is $e = 0.1$ a shown in figure 1.

$$\log P_n = P l_n + Q. \quad (5)$$

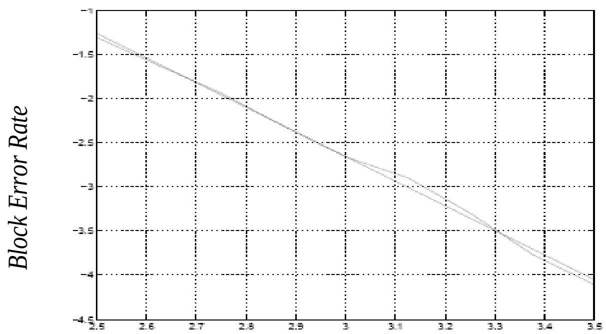
The channel BER e is inside the model parameters P and Q, and will not appear further .using equation (5) according to Gilbert-Elliot model. The optimization constraint can be written as follows.

$$\prod_{n=1}^{N} P_n = P. \tag{6}$$

For non variable N, considering equilibrium of the Lagrangian solution lies as

$$J = d_0 P_1 + \sum_{n=1}^{N-1} d_n P_{n+1} \prod_{m=1}^{n} (1 - P_m) + d_N \prod_{m=1}^{N} (1 - P_m) + \lambda (\prod_{n=1}^{N} P_n - P). \tag{7}$$

Block Error Rate with RCPC (e=0.12, Multi Channels)



1/channel Code Rate

Figure 1. Block error rate under different channel code rate at the rate of BER is e=0.12

Taking derivative of the above equation (7) with respect P_j and setting it to zero yield a system of equations. Inverting and subtracting two subsequent element of this system of equations gives.

$$(\frac{1}{P_{j+1}} - \frac{1}{P_j})(-\lambda P) = (d_j - d_{j-1}) \prod_{m=1}^{j} (1 - P_m) \tag{8}$$

Which is recursive solution for P_j? Solving for equilibrium state $j = N$ gives

$\lambda < 0$ .substituting in equation (8) it gives $P_{j+1} \geq P_j$

The optimal each block error are non decreasing, this analysis is completely general for static channel , and it can be applied with any progressive source code and anywhere in the channel coding for finding optimal time varying and invariant rate allocation between a progressive source coder and channel coder.

In the proposed scheme, it is necessary in the transmission of data, channel protection is time varying. To limit the rate impact of over head into account three facts first is, and there are only a finite number of channel codes in the system. Second, channel code is constant over each block and in the third; channel error protection is uniformly non-increasing [5].

3. Time varying static channels

The time varying static channel modeled as finite state Markov process [7]. According to G

& E model, the channel is described by binary symmetric channel (BSC) with a particular Bit error rate (BER).Bit error rate is denoted by E_b for noisy state (bad state) and E_g for less noisy state (good state).Because of instantaneous state of the channel and variation in BER it is proposed for single BER and it is denoted by E_{d} which designed for that. E_{d} can be set high with few bits available for source coding. And set different values of E_{d} to obtain the result as shown figure 2.

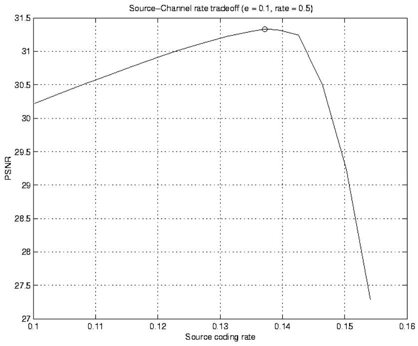


Figure 2. Effect of rate allocation in on end-to-end PSNR Experiment on baboon 512x512 size.

The behavior from above curve a conservative approach to protect error in static (memory less channel).in a 512x512 baboon image, compressed with SPIHT and DCT, combination of these is nothing but(Homogeneous Connected Region Interested Ordered Transmission Technique) HC-RIOT coder [7] is sent through BSC and it compatibility with RCPC used to protect error in static channel. According to modulation, coding and multi user decoding [8] for source block length is 225, to which is added 8bits of hamming code [9].If baboon is transmitted through static BSC with BER 0.12. The block error rates of the system under different code rate are obtained in this particular proposed system. Code rate can be decided by the equation (4).for optimization to protect the error at BER 0.1 and transmit 0.25 bpp.The impact of overhead on transmitting rate is 0.01bpp. According to our experiment for various channels sharing BER 0.12.table 1a shows the means and variance of PSNR in each channel. All static channels having more PSNR as compare to fading channels. If E_b putting highest value, decoding collapse due non compatibility. In comparison, the first bad state channel and second channel almost the same but good state of the channel first is 12 times better than channel second. The effect of bad state channel is dominant in all selected channels due to the some decreasing the value of PSNR as E_b increases from E_{d} .According to the experiment BER chosen to be at ,or very close to E_b . The transmitting process in choice of E_{d} is to have less digital image and more protection or more digital image data and less protection.

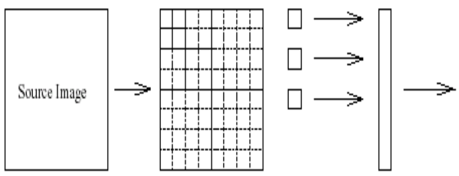


Figure 3. Source Image Homogenous Connected Region

Above figure is indicating the progressive transmission scheme according to HC-RIOT technique. if BER is varied the PSNR for the channel 4,5, shows , it observed that the best design BER again coincides with the BER of the bad state of the static channel as shown in figure 4.

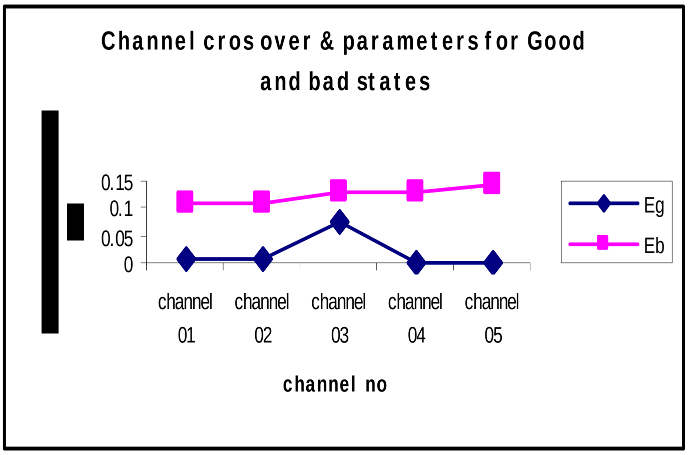


Figure 4. Channel cross over and parameters

Table 1. shows the means of PSNR in each channel

Average PSNR			
Rate	0.12	0.50	1.00
BSC	26.65	32.45	35.38
Channel- 01	26.57	32.30	34.98
Channel- 02	26.54	32.22	34.72
Channel- 03	26.42	32.12	34.67
Channel- 04	26.34	32.08	34.23
channel -05	26.13	32.01	34.12

Table 1a. shows the variance of PSNR in each channel

Variance of PSNR			
Rate	0.12	0.50	1.00
BSC	0.33	0.72	0.80
channel -01	0.59	0.90	1.23
channel -02	0.79	1.13	1.45
channel- 03	0.90	1.32	1.89
channel -04	1.12	1.48	1.98
channel -05	1.23	1..88	2.35

Table 2. Average PSNR for baboon 512X512 size over BSC with BER 0.12for fixed and variable

Rate	0.1	0.2	0.4	0.6	0.8
Fixed	26.33	28.64	31	33	35.3
Variable	26.83	28.97	32	33.5	35.2

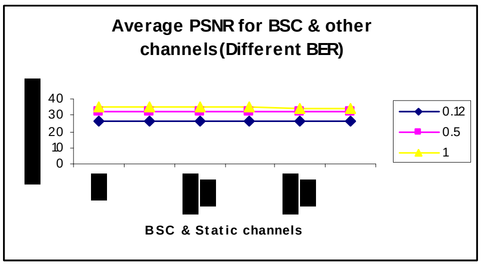


Figure 5. Average PSNR for different BER 0.12, 0.5&1.0

4. Hc-riot technique

HC-RIOT (Homogeneous connect region interested ordered transmission technique) [6] is nothing but the joined uniform part of the image having definable boundary, which is concerned for progressive transmission. It is introduced set DCT (blocks) approach is adapted to perform sub band decomposition followed by SPIHT (Set partitioning in Hierarchical tree)

Homogenous connected region interested ordered transmission technique, in this technique insignificant (Discrete cosine transform) DCT coefficient that correspond to the some spatial location in sub band [11]. Sub band can be use to reduce the redundancy by set partitioning in hierarchical tree(SPIHT) in addition .It is introduced the idea of how set partitioning can be used in sorting transform coefficients that image distortion is minimize during image transmission. DCT-SPIHT image compression reduce the computational complexity and improve the quality of the reconstructed image according to the threshold level can be transmit the coefficients, threshold level can be decided by using largest magnitude coefficients in transmission method Homogenous connected region interested ordered transmission technique can be implemented with the following steps to be used by the encoder.

Step 1: calculate the ‘n’ to select the threshold level:

$$n = \log_2 \left(\max\,(i, j)\, \left(C_{i,j}\right) \right) \qquad (9)$$

Step 2: for sorting purpose; followed by the pixel coordinates m (k) and sign each of the coefficients such that $2^n \leq \left|C_m\ (k)\right| < 2^{n+1}$ (Sorting Pass)

Step 3: output the n^{th} most significant bit of all the coefficients with $\left|C_{i,j}\right| \geq 2^{n+1}$ if required, those that had their coordinate transmitted in previous sorting passes

Step 4: Decrement n by one and to go to step 2.

The above steps that can be implemented and stop at the desired the rate or distortion normally, good quality images can be recovered after a relatively small amount of the coefficients are transmitted. In a practical implementation purpose the significance information is stored in three-ordered list as.

LIS: List of insignificant set contains sets of discrete cosine transform coefficients which are defined by tree structures [5] and which had been found have magnitude smaller than the threshold (insignificant)

5. Conclusion

This paper presents a new low complexity technique for Progressive Source Channel Embedded Coding of digital Image over Static (Memory Less) Channel based on HC-RIOT. The proposed system to find the optimal time varying rate for progressive joint source channel coding. This system can be applied to any progressive transmission and anywhere to transmit the digital image. For static channel the effect of channel error propagation to the decoder and instantaneous tradeoff between source and error protection bits. In this particular static channel, it generalized to a system for memory less channels. Simulation gives time varying allocation provides maximum up to 0.41dB.Desired gain obtained at high bit error rate and less transmission rate.

It is found that in static channel, optimal design bit error rate is always very close to the BER of the noisy state. Hence, this new system makes a fast and low complexity coding for static as well as fading channels.

Acknowledgement

The authors wish to thank the anonymous reviewers. The author would like to thank for useful comments and also thanks Dr. Kharadkar, principal GHRIET and Dr. D.D.Shah, principal GHRCEM for many discussions on the progressive source channel embedded coding of digital image over static channels and support provided by Raisoni Group of Institutions to perform this work in their PhD center.

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