Multiple Description Coding For Motion JPEG Video Transmission in UMTS

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ABSTRACT:
In this paper, we propose a multiple description video coding system for robust transmission of video signal. We split the video frames into odd and even frames, and encode each frame separately based on JPEG standard. We assume that each description is transmitted in through WCDMA physical layer that used in UMTS .The channel is simulated based on Gilbert/Elliot's model. We compare the result in threes cases: Video is reconstructed using only one description; video is reconstructed using both descriptions and finally video is reconstructed based on both description, and we do error concealment as well. The video quality is reported based on average peak signal to noise ratio for all cases for video sequences.

KEYWORDS: JPEG, WCDMA, UMTS.

1. INTRODUCTION

The UMTS is the major new third generation (3G) mobile communication system being developed within the ITUs IMT-2000 framework. It is related to a recent generation of broadband multimedia mobile telecommunications technology.

Many different methods have been used to increase the stability of systems in noisy channel, but most of them are complicated or expensive. Multiple description coding is a source coding method in which information is divided into two or more parts and this way; the stability of systems in noisy channels could be increased. There are far fewer limitations in the number of channels in UMTS. Thus, two channels could be used for each subscriber without increasing at the bit rates and bandwidth [7]. Some standards have been used for video coding, such as MPEG-X and ITU-H26X. However, the Motion JPEG standard is still popular as it is much less complicated [1]. Gilbert/Elliot's channel is used to simulate the channel in WCDMA physical layer [5].

2. UMTSRADIO SYSTEM

Direct Sequence Spread Spectrum (DS-SS), illustrated in Figure 1, and is another SS principle wherein the carrier frequency stays the same, but the signal to be transmitted is multiplied with a high bandwidth signal instead. This multiplying signal looks like a random signal, or noise, but is actually completely reproducible. The resulting signal obtains the same high bandwidth as the multiplying signal, which increases its robustness against interference. On the receiving end, the reproducible high bandwidth signal – the "code" – is multiplied with the received signal to recover the original signal.

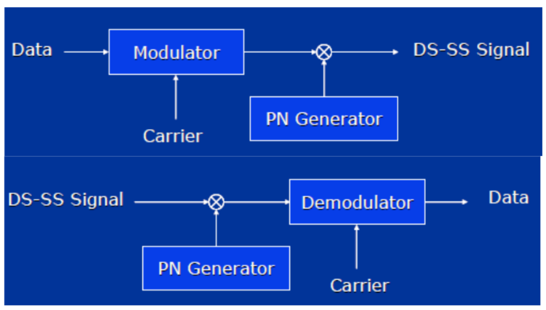


Fig.1. Direct Sequence Spread Spectrum (DS-SS)

The radio access scheme in Wideband Code Division Multiple Access (WCDMA) is DS-SS CDMA with the information spread over a bandwidth of about 5MHz with a chip rate of 3.84 Mcps. Modulation is QPSK in downlink and BPSK in uplink.

3. MOTION JPEG VIDEO CODING

One popular and low complexity format for video coding is Motion-JPEG. In this standard, each frame is divided into 8×8 blocks and is processed from left to right and up to down. The discrete cosine transformation is calculated for each block. Then this matrix is quantized and set by zigzag pattern. The encoding process is presented in figure 2.

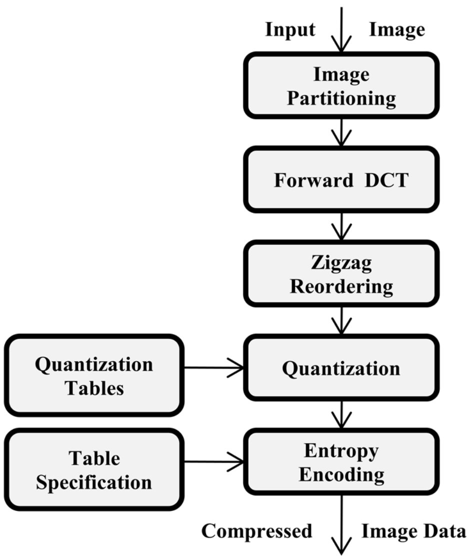


Fig. 2. The encoding process

4. CHANNEL NOISY

The Gilbert/Elliot model is widely used for modeling the error characteristics of wireless channel between two stations.

Consider a two state Markov chain with the states named Good and Bad (See Figure 3). Each state is assigned a specific constant bit error rate (BER). BERg, BERb (BERg<<BERb). In general, the bit error rates depend on the frequency and coding scheme used in environmental conditions and the number of paths between source and destination.

The state transition matrix is completely defined by the value Pgg (the probability that the next state is the good state, given that the current state is also the good state) and Pbb.

The main state sojourn time (duration of being in a state measured in number of steps in this state) is given by:

$$Tg = \frac{1}{1 - Pgg} \quad (1)$$

$$Tb = \frac{1}{1 - Pbb} \quad (2)$$

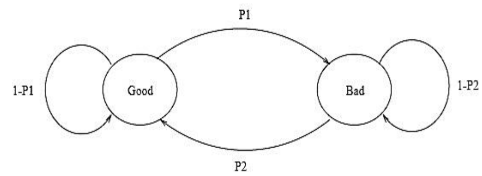


Fig. 3. A two state Markov channel

The parameters that set in this paper for Gilbert/Elliot channel are shown in the table1.

Table 1. Parameters of gilbert-elliot channel

Noisy Channel Parameters	
PGB	2.8×10^-4
PBG	2.5×10^-3
BERg	5×10^-6
BERb	5×10^-2
Modulation	BPSK
Initial State	-1
Packet Size	256
Bitrates(b/s)	384000
Signal Power(w)	1

5. MULTIPLE DESCRIPTION CODING

In the MDC approach, two or more descriptions of the same data are generated. These descriptions can be separately decoded.

Acceptable quality can be obtained when decoding each subset of the descriptions. The quality is proportional to number of received descriptions and full quality is obtained over decoding all descriptions.

The redundancy is beneficial in the case of single description reception, which helps the estimation of the missing description from the received one.

In receiver, if BER of the separated frames is lower than $\left(5\times10^{-3}\right)$, the quality is bad and the block must be fixed.

When both descriptions are received, the redundancy impairs the rate-distortion performance of the system.

A single diagram for MDC is shown in figure 4.

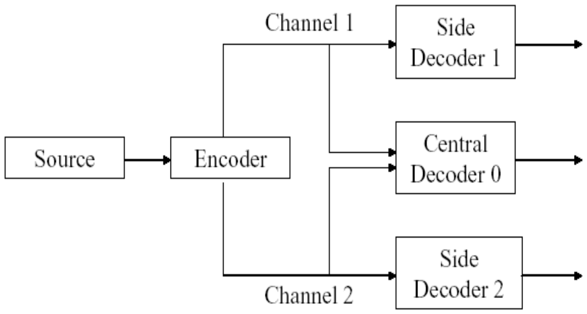


Fig. 4. A simple MDC diagram

Timed description is used in this paper. It means there is one description for odd frames and one for even frames.

6. ERROR DETECTION AND CONCEALMENT ALGORITHM

There are several methods for error detection and correction in communication channels. One of these methods that have been used in WCDMA is using CRC, Pilot and checksum bits during the frames.

In this paper, these bits are used for error detection and innovative algorithm for error correction.

In this method, some bits as check bits are added to each frame, after being coded with JPEG standard and before sending to UMTS channel. 8 bits are added after each 256 bits (one block) and 32 Pilot bits are added to coded frame before and after each frame.

Table 2. Probability of consequent damage frames

Video	Q	One channel		MDC	
		Number of damaged frames	Probability (%)	Number of damaged frames	Probability (%)
Carphone	25	28.2	9.4	2.3	0.76
	50	32.3	10.7	3.1	1.03
	75	35.1	12	4.6	1.53
Foreman	25	31.9	11	1.1	0.36
	50	30.5	10.2	0.8	0.26
	75	41.4	13.8	1.9	0.63
Claire	25	22.6	7.6	0.2	0.06
	50	26.4	8.8	1	0.33
	75	27.2	9	0.5	0.16
Miss_am	25	25.3	8.4	1.1	0.036
	50	30.5	10.2	0.9	0.3
	75	29.9	9.9	2	0.66
	Mean	30.11	10.03	1.625	0.54

6.1. Error Concealment Algorithm

In this approach, all or parts of damaged frame are reconstructed by the simultaneous frame of another channel. The problem of this method is: if both of two simultaneous frames are damaged, this method cannot recover both frames. Therefore simultaneous damage of both frames has been calculated (It is presented in table 2). The number of probabilities for 300 frames of 4 videos with 20 times repetition are calculated and shown in table 2. (Q is the Quality of JPEG encoder).

Of course, this probability is very low. Thus this program can produce better quality of the video.

7. SIMULATION PROCESS

7.1. Simulation for Basic Method

In this stage, 4 standard QCIF videos are used which are called: Carephone, Claire, Foreman and Miss am (300 frames of each video). Each video is separated into 300 frames and each one has 144×176 pixels. Each frame is separated into 8×8 blocks and coded by JPEG standard. Then binary matrix is produced and sent to WCDMA physical layer with Gilbert/Elliot channel. The frames are decoded and pasted after receiving this signal and help make the video.

7.2. Simulation With Mdc

In this method, after coding each frame, the same videos are being used and constant frames are being sent to different WCDMA channels (by the same characteristics). Then receiving frames are pasted to each other alternatively from two channels.

All of these simulations have been done with different qualities of JPEG.

7.3. Simulation With Mdc And Concealment Algorithm

In this method, all of the stages for simulation have been done like stage 6.2 , the only difference is that after receiving each frame the quality of them is calculated and if there is low quality the correction algorithm is used to correct the damaged frame by using the previous frame. The diagram of this method is shown in Figure 5.

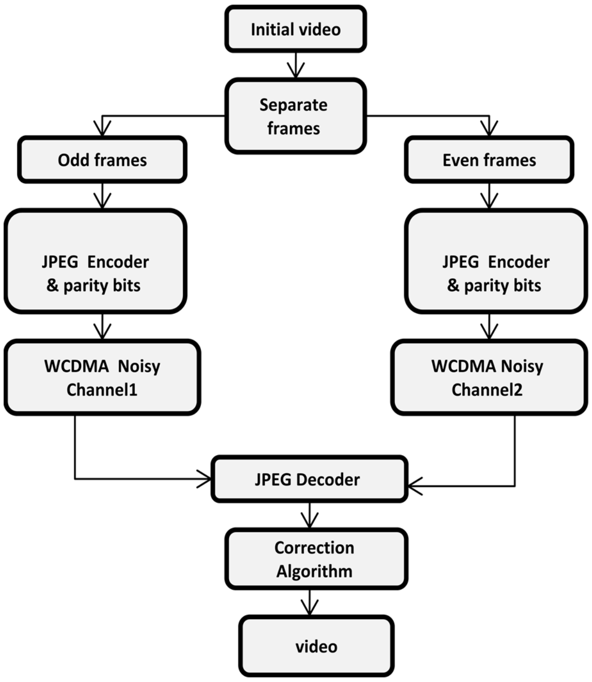


Fig. 5. MDC and correction method

After simulation is done (for 300 frames of 4 standard videos), the results shows that in stage 7.3, the quality of the video becomes higher than the other methods. The quality is calculated byBER and tested by PSNR.

In figures 6,7,8,9 PSNR is presented for all methods and all qualities of JPEG.

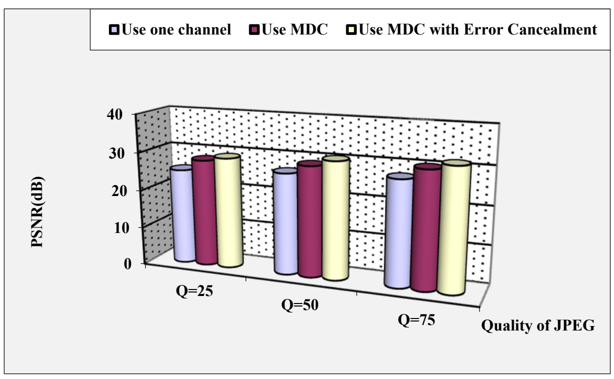


Fig. 6. Comparison of 3 methods for the Carephone video

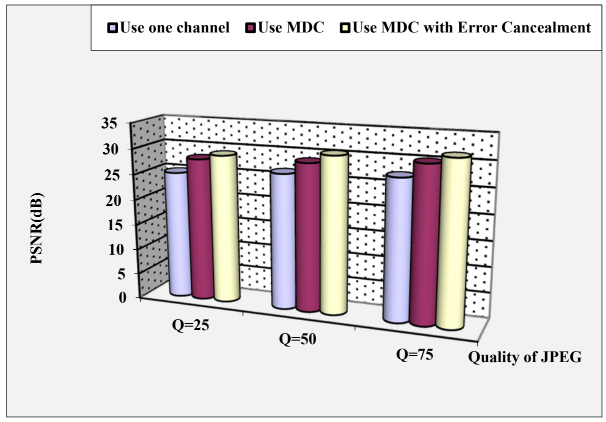


Fig. 7. Comparison of 3 methods for the Claire video

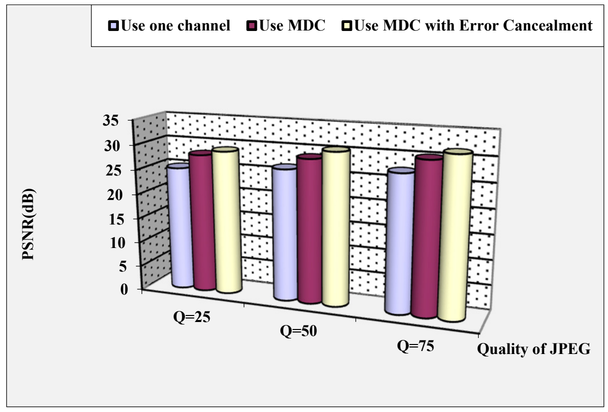


Fig. 8. Comparison of 3 methods for the Foreman video

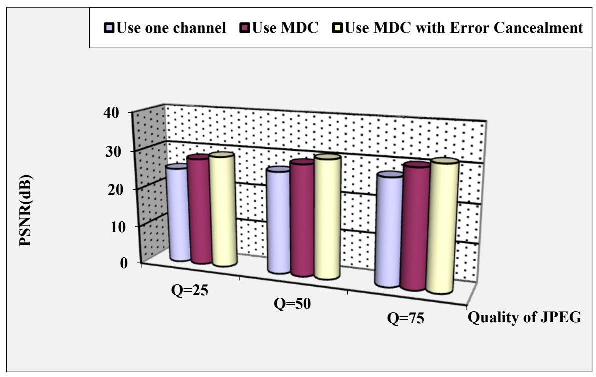
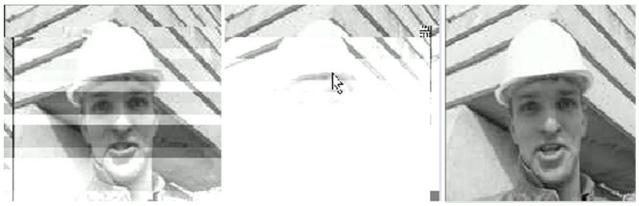


Fig. 9. Comparison of 3 methods for the Miss_am video

8. RESULTS

Results of simulation for Carephone video is shown in Figure 10 & table 3.



3 continuous frames after transmition over UMTS channel

3 continuous frames after using MDC method

3 continuous frames after using MDC method and correction

Fig. 10. Comparison of 3 methods for 3 continuous frames of the Foreman video

Table 3. PSNR & BER in verity of Quality of JPEG

Video	Q	One Channel		MDC		MDC Using Correction Algorithm	
		PSNR(dB)	BER	PSNR(dB)	BER	PSNR(dB)	BER
Carphone	25	25.33	8.85×10^-3	29.9	7.12.×10^-4	31.1	8.2×10^-5
	50	26.91	4×10^-4	30.9	8.58×10^-4	32.3	8.9×10^-5
	75	27.4	4.05×10^-4	32.1	8.9×10^-4	34.2	9.46×10^-5
Foreman	25	25.12	7.34×10^-3	28.1	8.11×10^-4	29.12	8.94×10^-5
	50	26.5	9.89×10^-3	28.85	9.65×10^-4	30.54	1.03×10^-6
	75	27.4	2.03×10^-4	30.22	1.45×10^-5	31.57	1.2×10^-6
Claire	25	28.25	5.14×10^-4	31.2	3.2×10^-5	33.8	1.2×10^-6
	50	29.5	6.96×10^-4	33.2	4.65×10^-5	34.9	3.5×10^-6
	75	30.87	8.9×10^-4	34.9	4.86×10^-5	36.2	4.12×10^-6
Miss_am	25	31.7	9.94×10^-4	32.8	5.2×10^-5	33.6	3.46×10^-6
	50	32.11	2.14×10^-5	33.12	5.8×10^-5	35.1	4.95×10^-6
	75	32.12	3×10^-5	34.16	6.5×10^-5	35.9	5.58×10^-6

REFERENCES

[1] JPEG Official Web Pages: http://www.jpeg.org

[2] UMTS Official Web Pages: http://www.3gpp.org

[3] J. Maciej, M. Dohler, H. Aghvami, **"Understanding UMTS Radio Network Modeling, Planning and Automated Optimization Theory and Practice"**, *New York: John Wiley & Sons*, 2006.

[4] H. Holma, A. Toskala, **WCDMA for UMTS: Radio Access for Third Generation Mobile Communications, New York**, John Wiley & Sons, 2002.

[5] A. Laourine, L. Tong, 2009, **"Betting on Gilbert-Elliot Channels"**, *in Cornell University on Adaptive Communications Laboratory*. Ithaca. NY 14853.

[6] Sh. Shirani, M. Gallant, and E. Kossentini, **"Standard-compliant Multiple Description Video Coding,** *"in International Conference on Image Processing, Proceeding of IEEE*, Vol. 1,pp. 946-949, 2001.

[7] K. Goyal, **"Multiple Description Coding: compression meets the network,"***in IEEE Signal processing magazine*, pp. 74-93, September 2001.

[8] M. Mohammadi, R. Amirfattahi, **"Using Multiple Descriptions for a JPEG Coder"**. *Majlesi Journal of Electrical Engineering*, Vol. 1, No. 3, 2007.
[9] Puri, R.,Ramchandran, K**.,"Multiple Description Coding using Forward Error Correction Codes,"***Proc. 33rd Asilomar Conf. on signal and systems*, vol.1, pp.342-346, Pacific Grove, CA.1999.