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OPTIMIZING TRANSMISSION OF WIRELESS VIDEO SURVEILLANCE USING COMBINED UEP STRATEGY

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ABSTRACT

Applications of Wireless communications are undergoing major expansion and have attracted a great attention not only in the media but also in imagination of the public. However, wireless channels are known to generate a high number of errors which perturb complex multimedia applications such as image or video transmission. While transmitting source-encoded data, not all information bits are equally important, due to the different sensitivity of the source decoder to errors. We have studied rate-compatible punctured convolutional (RCPC) codes concatenated with hierarchical modulation to achieve bit stream for video application. In order to optimize the protection rate and ensure better protection an Unequal Error Protection (UEP) strategy is introduced, where we take the hierarchy of the information into account.

KEYWORDS: Hierarchical modulation, RCPC (Rate-Compatible Punctured Convolutional) code, Performance of RCPC codes, UEP, wireless video surveillance transmission.

INTRODUCTION

Wireless technology has become the most exciting area in telecommunication and networking. The rapid growth of mobile telephone use, various satellite services, and now the wireless Internet are generating tremendous changes in telecommunications and networking. Wireless is convenient and often less expensive to deploy than fixed service, but wireless is not perfect. There are limitations, political and technical difficulties that may ultimately prevent wireless technologies from reaching their full potential. Regardless of the design of the transmission system, there will be errors, resulting in the change of one or more bits in a transmitted frame. For the sake of analysis, we will categorize our solutions as encoder side, decoder side, and in the existence of reverse channel, as similar to many other transmission schemes, wireless channels can be analysed in these parts as seen in figure 1.

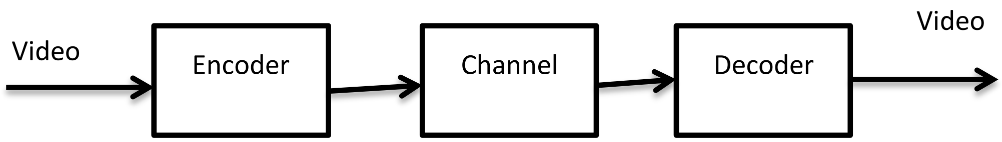

Figure 1: video over wireless channel [3]

A common method to add redundancy is forward error correction (FEC), which transmits redundant information of each packet in subsequent packets. In this sender based scheme, a lost packet can be recovered from the copies piggybacked in subsequent packets should they be received successfully. In this scheme, loss recovery is performed at the cost of higher latency [5]. In many cases, however, the loss of successive packets is correlated, due to the way packets are dropped as networks get congested and router buffers are becoming full. A packet loss may usually be followed by a burst of loss, which significantly decreases the efficiency of FEC schemes. In order to combat burst loss, redundant information has to be added into temporally distant packets, which introduces even higher delay. Hence, the repair capability of FEC is limited by the delay budget.

PREVIOUS WORK

Many researches [8],[9],[13],[16] have proven the use of UEP strategies combining with other strategies. In [1] two techniques the traditional unequal error protection (T- UEP) technique is the most popular they have consider a MPEG4 as a source encoder which is most used today, which can protect the different parts in a MPEG4 video packet (VP) with different channel coding rates based on rate compatible punctured convolutional codes shows that the improvement for decoded video quality after transmission over wireless channels when the channel performance is very poor. In [2] efficient Error correcting codes are used with the combination of UEP scheme and it shows that it performs by making use of the video error propagation model. Using UEP strategies plus some error correcting code and modulation has been shown in [2] that in terms of average PSNR (Peak signal-to-noise ratio).

DATA PARTITIONING AND UNEQUAL ERROR PROTECTION (UEP)

When the communication resources are limited, an alternative to heavier compression is to implement unequal error protection for different parts of the video data. The idea of UEP is to allocate more resources to the parts of the video sequence that have a greater impact on video quality, while spending fewer resources on parts that are less significant Although video compression algorithms enable high compression rates they are far from perfect. Information content, hence importance and motion vectors are more vulnerable to errors. Data partitioning is grouping the bit their relative importance. After data partitioning, unequal error protection can be used to heavily protect more important parts of the bit-stream. RCPC codes [8] are constructed by puncturing a convolutional code called the parent code. Let the code rate and constraint length of the parent code be R = 1/n and L respectively. The parent code is completely specified by the n generator polynomials

$G^j(D) = g^j_0 + g^j_1 D + \ldots + g^j_{Lc-1} D^{Lc-1}$, $j = 1, 2, \ldots, n$, where $g^j_i \in \{0, 1\}$ (1) [17].

The Puncturing is done according to the rate compatibility criterion, which requires that lower rate codes use the same coded bits as the higher rate codes plus one or more additional bit(s). The bits to be punctured are described by an n x p puncturing matrix P consisting of zeros and ones, where p is called the puncturing period. At time instant t, the output from each generator $G^j(D)$ is transmitted if P(j, t mod p) = 1 and punctured otherwise. Here, P (a, b) denotes the element on row a and column b in the matrix P. The number of columns determines the number of code rates and the rate resolution that can be obtained.

Rate Compatible Punctured Convolutional (RCPC) codes are especially useful UEP. In RCPC codes, data is first coded using a low rate convolutional coder. Higher rates are simply obtained by puncturing, i.e. not transmitting certain locations of the coded bit-stream. Decoder simply inserts zero in places of punctured bits and decodes the bit-stream.

THEORETICAL PARAMETERS

BER (*Bit Error Rate*)

To measure the quality of a signal one of which can be seen from the formulation of each error bit (bit errors) that occur when transmitting information from the sender to the receiver by comparing the output data with the original data or input data.

$$\mathrm{BER(Pb)} = \frac{\text{Sum Of error bit occured}}{\text{Sum of Bit Total Sent}} \ldots\ldots\ldots\ldots(2)$$

1. BPSK BER theoretical calculations on Rayleigh Fading channel

$$\mathrm{BER_{BPSK-FADING}} = \frac{1}{2}\left[1 - \frac{1}{\sqrt{1+\frac{1}{E_b/N_0}}}\right] \qquad (3)$$

2. QPSK BER theoretical calculation in Rayleigh fading channels

$$\mathrm{BER_{QPSK-FADING}} = \frac{1}{2}\left[1 - \frac{1}{\sqrt{1+\frac{1}{E_b/N_0}}}\right] \qquad (4)$$

The error generated in received data represent by probability of error using following formula [1].

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$$P_d = Q(\sqrt{2Eb/No}) \quad (5)$$

This parameter affected by signal to noise ratio, transmission speed, bandwidth and channel properties.

Signals to Noise Ratio

Parameter Eb/No

Eb / No ratio is the ratio of energy per bit to noise energy in the spectral density. Eb / No as a measure of signal to noise ratio in digital communication systems. It is measured that the input signal or information from the sender to the receiver and is used as a measure of how strongly a transmitted signal [4].

$$\frac{\mathrm{Eb}}{\mathrm{No}} = \frac{\mathrm{S}}{\mathrm{N}} \times \frac{\mathrm{W}}{\mathrm{R}} \quad (6)$$

Eb/No = Energy bit per noise (dB)
S = Signal Energy (watt)
R = Bit rate (bit/detik)
N = Power of Noise (watt)
W = Bandwidth (Hertz)

BASIC PRINCIPLE OF RCPC

The main advantages of RCPC code are resumed in a following table 1.

Table 1: performance of RCPC compared to other error control system

	RCPC system	Ritual error control coding system
Channel condition	Change according to the source and channel	Fixed
Correction capability	Change according to the source and channel	Adapt to average or worst
Code rate	Using punctured table to provide flexibility	Match to specific

It has clearly explain the mechanism of RCPC coding in [18], if we have *nP* encoded bits and *l* encoded bit deleted (punctured) and not transmitted. Therefore *P* information bits are mapped to *nP-l* code bits. So, the code rate is increased from $R=1/n$ to

$$\mathrm{Rpunc} = \frac{\mathrm{P}}{\mathrm{nP}-l} \quad (> \frac{1}{n} = R) \ (7)$$

$L<(n\text{-}1)P$ must be valid to guarantee a code rate smaller than 1 to be able to reconstruct the information bits from encoded bits. *P* is called Puncturing period and the rate $1/n$ is called Mother code. The positions of encoded bits to be punctured are fixed in a puncturing pattern. With the increasing of *P* nearly all code rate between $1/n$ and 1 can be achieved.

Many application of the RCPC are discussed in [17] Here we have chosen to present the two main that we think it's useful for our review.

- ✓ Transmission channels with varying quality where the code rate is adapted by an ARQ (automatic repeat-request) method (if a feedback channel is available as in figure 1) according to the channel properties.

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Similarly the punctured code is used for good channels and only if the channel quality is deteriorated the punctured position are transmitted as well to raise the correctability.

- ✓ At the data source where the many bits within a frame have varying importance and therefore require a varying error protection too. This is what exactly is called UEP coding.

The following diagram in figure 2 explains why people said that Convolutional codes are computer search methods are not constructed by analytical methods but by trial and error methods. Convolutional encoders do not transform information words into code words block by block, but transform the whole sequence of information bits into a sequence of encoded bits by convolving the information bits with a set of coefficients.

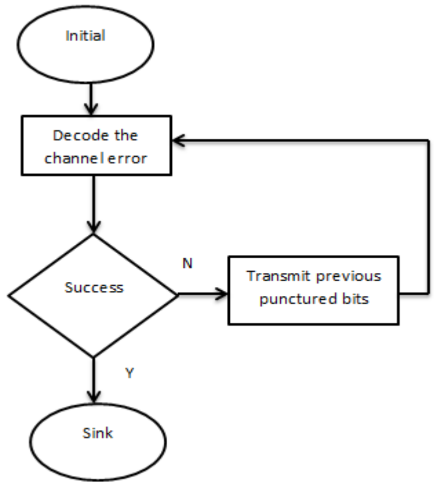

Figure 2: RCPC rule.

HIERARCHICAL MODULATION

One most known technique for optimizing using UEP, is Hierarchical modulation. To provide unequal transmission reliability for high priority (HP) and low priority (LP) bits. In [4] several hierarchical constellations, where the hierarchical parameter adjusts the distances of the symbol points in the constellation. In the same review they have considered the hierarchical parameter α, is the ratio of the distances of the symbols to the origin on one side of the constellation. from one constellation to another, they change α so that HP bits and LP bits will have different error probabilities. Hierarchical 16-QAM (H-16QAM) and hierarchical 64-QAM (H-64QAM) are simple extensions to H-4PAM and H-8PAM, respectively, by considering in-phase and quadrature components as two independent constellations. [7] .

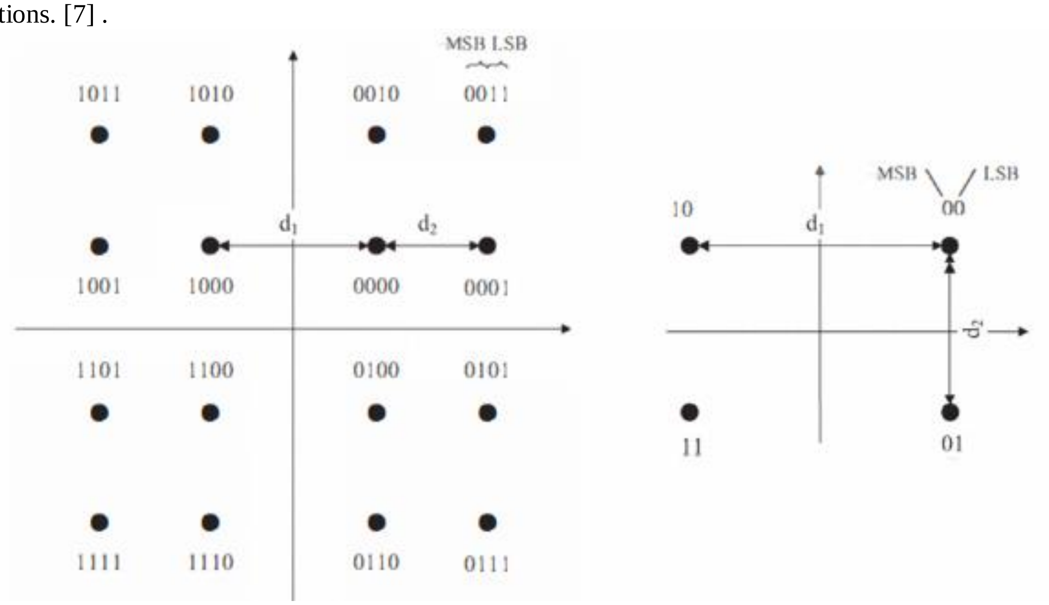

Figure 3. Constellation diagram of hierarehieal 16-QAM and QPSK [

In the hierarchical modulation, the core principle is that the minimum distance between MSB is longer than that between LSB. Figure 3 shows the constellation diagram of the hierarchical 16-QAM and QPSK. In 16-QAM constellation diagram, the higher two bits indicate the constellation point belongs to which quadrant, so the minimum distance between two quadrants is represented by two MSB, namely dl. The minimum distance between two points in one quadrant is represented by two LSB, namely dz. For QPSK, dl is the minimum distance between two points at the x-axis direction which is represented by one MSB, while dz is the minimum distance between two points at the y-axis direction which is represented by one LSB. a = ddd2 is introduced to express the ratio of error protection ability between MSB and LSB.

SYSTEM OVERVIEW

The region of interest video coding is usually used to improve the quality of important areas in a video. Using UEP coding techniques on some communication patterns can be preserved without immolating the bandwidth. In noisy communication environments such as cellular mobile channels, it's not sure that the decoded video at the receiver end preserves the vital information. In the strategy, depending on the source encoder, different code can be used here we have choose RCPC codes because it's the most adaptable with UEP. As for error protection and according the application specific Error correcting code (ECC) is applied. In this paper we present a technique of UEP association with hierarchical modulation in other to provide the more reliable technique for video encoding for wireless transmission. Foreground packets are protected with a stronger error correction code than background packets. The technique present in [4] look same as the same we shown and it improves to save some channel capacity for encoding at a better quality.

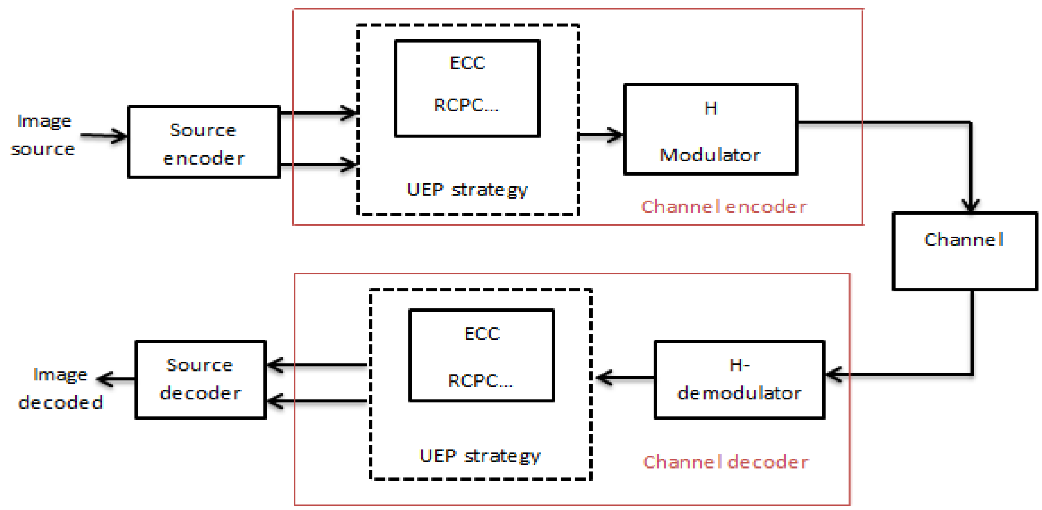

Figure 4: A generalized block diagram of the proposed UEP technique

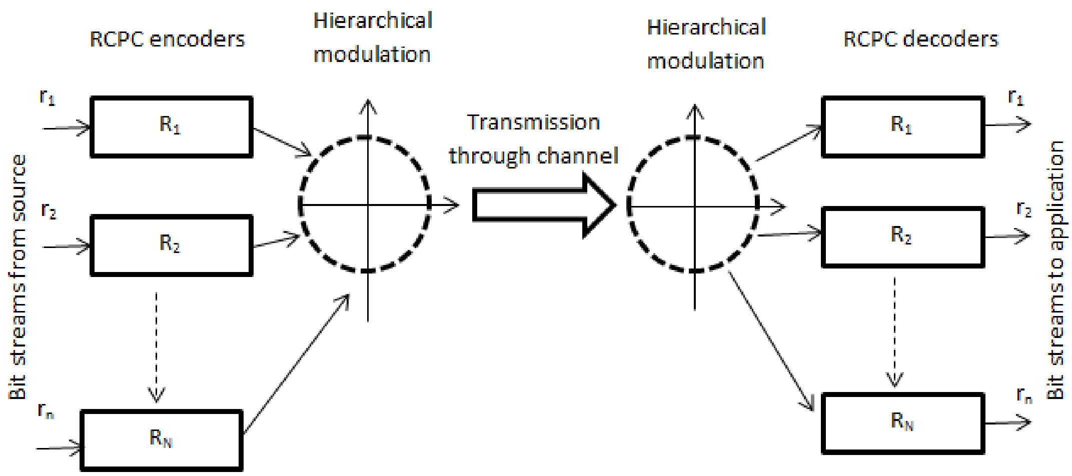

Figure 5. simplified block diagram.

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Basically the proposed of our framework is composed of RCPC codes followed by the hierarchical PAM/QAM/BPSK... The code rates of the RCPC codes are denoted. $\{R_1,R_2\ldots,R_N\}$ where R_k by represents the RCPC code rate for the *k-th* priority bit stream. The RCPC code rate is expressed as

$$R_k = P/\,(P+l_k) \quad (8)$$

where P is the period of the mother convolutional code of the RCPC code and l_k is the length of the redundancy bits. The rates of the source bit streams of the various priorities are denoted by

$$\{\, r_1, r_{2,}\ \ldots r_N, \} \text{ (bits/sec).}$$

The channel symbol rate is *C* symbols/sec. We denote E_b as average energy per information bit and E_{sym} as the average energy per modulation symbol. The average energy per information bit can be expressed as

$$E_b = \frac{E_{sym} C}{r_1 + r_2 + \ldots + r_m}. \tag{9}$$

RESULTS

Using Communications System Toolbox of Matlab for the simulation of a communication system in order to Minimizing the BER By plotting the bit error rate versus signal to noise using Hierarchical modulation and RCPC code . Here is some parameters:
Frame Length: 6000
Error target: 500
Maximum Number of transmission: 5e6
Code rate: 3/4
We compare the simulation results using an approximation of the bit error probability bound for a punctured code and a theoretical bound.

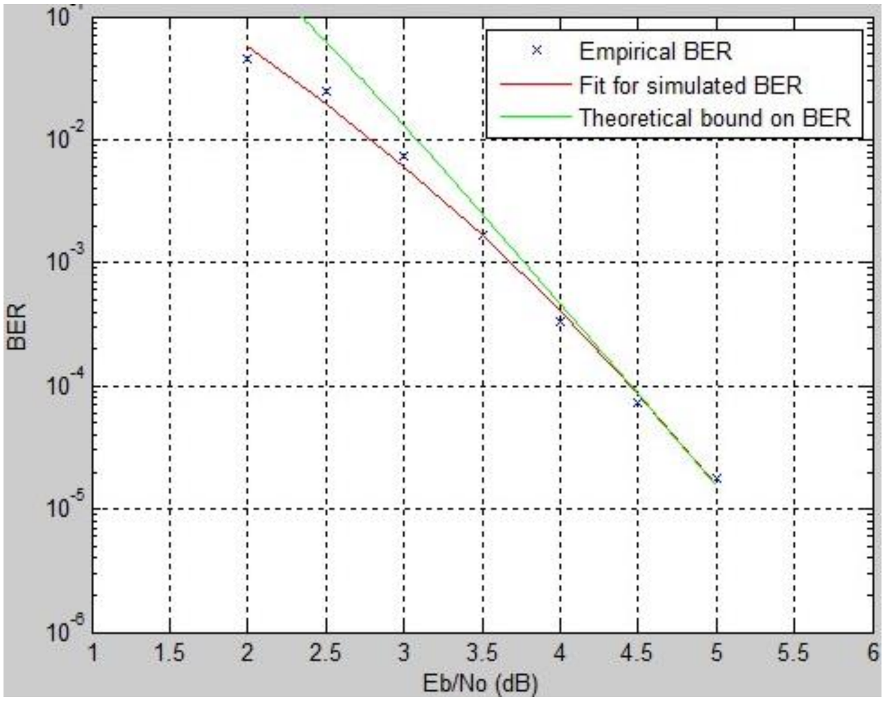

***Figure 6*: SNR Vs BER plot.**

Since the SNR is high, the number of errors introduced during the transmission is low and these can easily be corrected with a higher code rate. For lower SNR a value, where maximum noise is present gives the maximum error in received data. To avoid maximum error and to get actual transmitted data at receiver in noisy condition, efficient method is "Error Correcting Codes" used in receiver side. As the SNR values goes increasing , the BER values goes decreasing for a channel. This means maximum error gets corrected at receiver using convolution code as we can see in the graph comparing to theoretical bound . The convolutional codes are useful in dealing with random errors instead of bursty errors. Convolutional codes can be used with block codes in order to provide good performance in case of burst errors, as block codes are good against burst errors. The proposed scheme improves the quality of video communications by providing unequal error protection to the prioritized sequences.

Table 2: comparison between BER using RCPC code and Theoretical BER

E_b/N0 (dB)	Empirical BER	Theoretical BER	BER using RCPC code in AWGN channel	Target Number of error transmission	Frame length
2	3.37		3.4	300	3000
3	1.36	1.36	1.30	300	3000
4	0.34	0.32	0.35	300	3000
5	0.07	0.076	0.05	300	3000

CONCLUSION

Probability of bit error will increase if more no. of bits transmitted over limited bandwidth. In this paper, we have proposed the UEP technique to strengthen the robustness of the transport of video over wireless channels. The unequal error protection scheme is designed to provide relatively higher protection, i.e., lower BER, to the data with higher significance information.

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