FEC and UEP Scheme for Multimedia Transmission over Wireless Channel

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***Abstract*-** Due to the fruitful and diversified contents of multimedia traffic and susceptible circumstances of wireless communications, using unequal error protection (UEP) is now an active research subject . In this paper we propose a error rate weighted transmission scheme that combines both the convolution coding and non-uniform QAM schemes for transmitting H.264/AVC video data , which taking into consideration the non-uniformly distributed importance of intrtacoded frame (I-frame) and predictive coded frame (P frame) as well as the sensitivity of the coded bitstream against transmission errors. The non-uniform QAM constellation are used to give different degrees of the error protection , the transmission system is evaluated under AWGN .Simulation results indicated that the strategy produces a significant improvement into the peak signal-to-noise ratio (PSNR).

***Keywords*- - H.264/AVC, non-uniform QAM, convolution coding, UEP.**

I.Introduction

Multimedia transmission that requires guaranteed quality of service (Qos) will play a more and more important role in future wireless communications systems. Basically, it is desirable that we can resist the channel noise as much as possible in such transmissions. Therefore, to study the more reliable transmission systems is still an active research topic. As the video compression standards have been developed for relatively error free environments they cannot be directly transferred to a hostile mobile environment due to the extensive employment of variable length coding techniques which are error sensitive since a single transmission error may result in an undecodable string of bits. Therefore an essential issue is how to protect highly error sensitive video information against hostile mobile environments.[1,2] Several error resilient video coding techniques [3] have been proposed in order to minimize the effects of the transmission errors on the reconstructed video image quality. The error resilience techniques supported in the H.264 such as slice structure, data partitioning and Flexible Macroblock Ordering (FMO) have been designed to address this issue and make the generated bit streams more robust to transmission errors. The data partitioning is an effective layering technique which partitions the compressed data in separate units of different weighted importance. To improve the transmission quality, higher error protections are applied to those more important units of the coded data. In the recent video communication systems, layered coding with unequal error protection (UEP) has become the most popular and effective error resilience scheme. Unequal error protection (UEP) of coded video bit-stream is one of the most successful techniques .The main idea of Unequal error protection (UEP) is based on the fact that bits in a compressed video stream are not equally important .For example the motion vectors and picture header are much more important than the texture video data. [2] The reconstructed video quality will be severely degraded when errors occur on the important bit stream and these important bits should be given a higher protection order then the rest of the video bit-stream. The hierarchical modulation is another way of the (UEP) ,in which the high priority data bits (HP) of the coded video are mapped to the most significant bits (MSB) of the modulation constellation points while the low priority data bits (LP) of the coded video are mapped to the least significant bits (LSB) of the modulation constellation points [3,4]. The overall video quality will be improved compared with non-hierarchical modulation at low channel signal to noise ratio (SNR) conditions since the highly sensitive HP data bits are mapped to the MSBs of the HQAM with low BER. The Unequal error protection (UEP) employing the hierarchical quadrature amplitude modulation (HQAM) was proposed in [5] .

This paper presents the proposed unequal error protection (UEP) scheme based on the non- uniform QAM with convolutional coding to transmit H.264/AVC coded video , which takes into consideration the non-uniformly distributed importance of I-frame and P-frame. The protection provided to the compressed video bits-stream is non –uniformly distributed between the video frames to minimize the picture quality degradation due to the transmission errors. The paper is organised as follows.In section 2 , an overview of non-uniform 16 –QAM is given .Section 3 shows the proposed UEP and results are presented in section4 .Conclusions and future work are given in section 5.

II. NON- UNIFORM 16-QAM

A The property of Gary coded QAM

QAM were initially proposed to provide different classes of data to users in different wireless reception conditions [6,7] The 16-QAM constellation naturally forms two different-integrity sub-channels Fig.1 show the constellation of 16-QAM modulation.

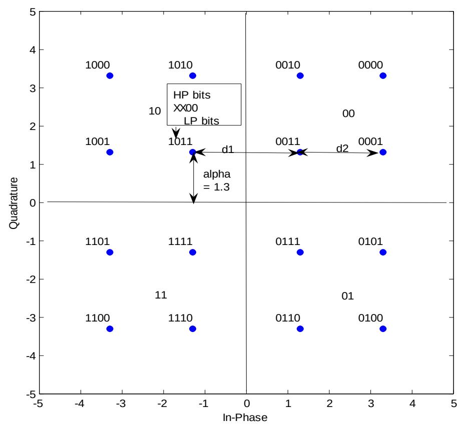

Figure 1. 16-QAM Constellation mapped with gray code.

From the property of gray encoding, the coded symbols differ only one bit between neighboring symbols, and the frequency that “0” and “1” change each other in lower significant bits is higher than higher significant bits. From this observation, we find that in N bits of gray code, the number of times i-th bit occurs in the transformation between “0” and “1” are $2n\text{-}i\text{-}1$. This property manifests itself that the particular bits in different positions will result in different error rates after impaired transmission. The main parameter for defining one of these constellations is the ratio between distances d1 and d2 as shown in Figure 1:

$$\alpha = d2/d1 \qquad (1)$$

where d1 and d2 are the minimum distance between points inside each quarter .The first sub-channel (HP) is formed by the two most significant bits (MSBs) of the four bit symbol, and the second sub-channel (LP) is formed by the two least significant bits (LSBs) of the symbol.
Each symbol *s* of the constellation can be written as [8]:

$$s= \left(\pm\frac{d1}{2}\pm\frac{d2}{2}\right)\pm\left(\pm\frac{d1}{2}\pm\frac{d2}{2}\right)j \qquad (2)$$

Bits transmitted via the HP sub-channel are received with a lower probability of error than those transmitted via the LP sub-channel. The splitting of the symbol into sub-channels leads to improved Bit Error Rates (BER) for the channels that carry the most important information of the video. The bits from the H.264 video source encoder that are most sensitive in terms of picture quality are assigned in the HP sub-channel and the remaining bits assigned in the LP sub-channel.If α =1 the resulting constellation is become a uniform 16-QAM, To improve the transmission efficiency of the system, higher error protection can be applied to the most important data of the coded video data by using 16-QAM with α > 1. We can differentiate and control the BER of the LSB and MSB within a mapping, respectively. Increasing d1 will increase the robustness of MSB against channel noise at the expense of sacrificing the LSB robustness against noise. Figure 2 illustrates a BER performance of the non-uniform 16-QAM in an additive white Gaussian noise (AWGN) channel for comparison non-partitioning (STD) was presented.

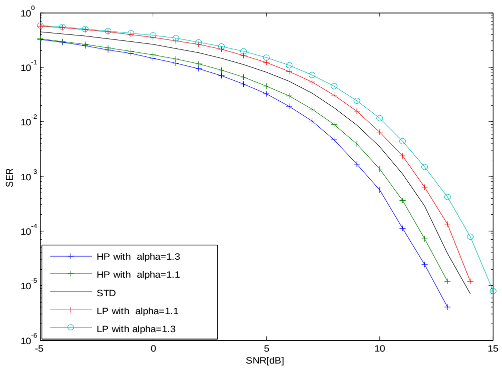

FIGURE 2 .BER VERSUS SNR FOR A RANGE OF ALPHA VALUES FOR 16-QAM .

B .The Relation of FEC,Non-uniform16-QAM

Although using the non-uniform QAM is able to reduce the error probability of those significant bits, it may also increase the error rate of those less significant bits. For this we may need to compensate such side effect. One easy way is to employ the FEC to improve such situation. A simple approach is to add the convolution encoding, into both channels. Simulation results show that using non-uniform QAM with FEC can reduce overall BER as shown in Figure 3.

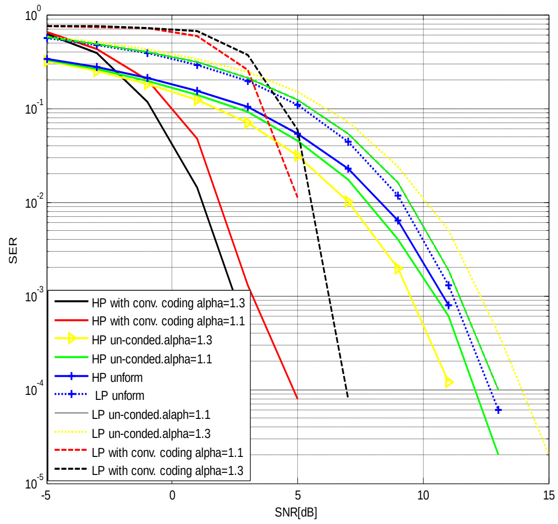

Figure 3 . Comparing BER of UEP with and without convolution coding.

III Proposed System

A. System Construction

The system block diagram of our proposed UEP scheme is shown in Figure 4 In this scheme, HP bits of the H.264/AVC coded video data are mapped to the MSB’s of the modulation constellation points and the low important (LP) bits are mapped to the LSB’s. The difference between using equal error protection (EEP) and our proposed UEP mainly lies in the way of the EEP that it doesn’t consider the weighted importance of bits and thus all bits are mapped into the points of the modulation constellation randomly. Video bit stream in our proposed UEP is divided into two level of importance, namely HP and LP data. HP data is the compressed video bit-stream, which is the most sensitive to transmission errors and the reconstructed video image quality will be severely degraded when transmission errors effect on this data and therefore a higher amount of protection is allocated to protect the HP data. Compared with the HP data, errors that effect on LP data will not cause significant distortions on the reconstructed video image and therefore a lower amount of protection can be applied. Since the two MSBs of the constellation points in hierarchical 16-QAM have lower BER than the two LSBs, they are used to transmit HP data while the two LSBs are used to transmit LP data.Furturemore the convolution code (CC) was used in both channels to decrease the overall error rate in the system.

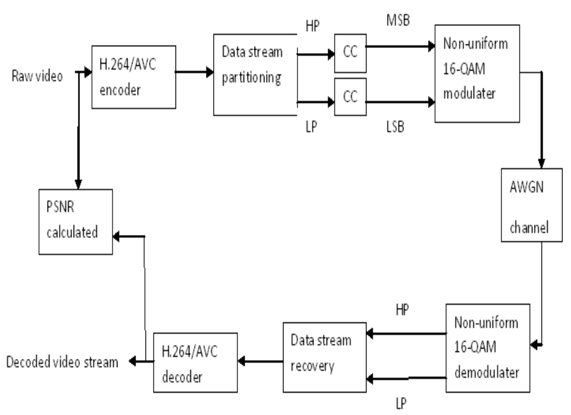

Figure 4. Block diagram of the proposed UEP scheme.

*B. UEP Assignment of the H.264/AVC video***.**

Fig shows 5 the group of pictures (GOP) , the first frame in a GOP which is an-I frame contain a lot part of picture data. , is classified as HP data , while the last six frames which are P frames record the different parts of two neighboring pictures, like motion vector.are classified as LP data , the frames in the GOP have descending important area , so the first frame should have a higher protection .The transmission errors depend on the error position of the frame in the GOP , and when an error occurs in beginning of a GOP the more frames are affected , while the errors in the last frames do not affect any other frames. The coded video data should be partitioned in a way that the first frame in a GOP is more protected than the last frame of the GOP.

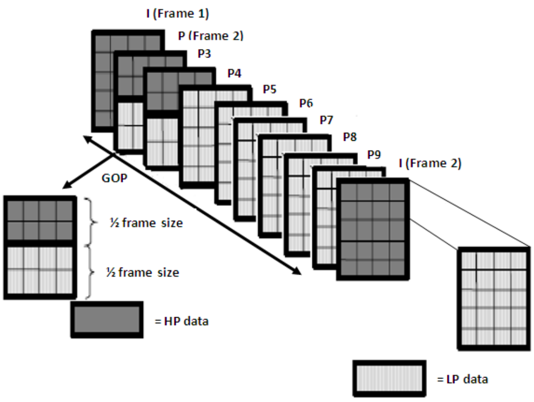

Fig5 Proposed UEP of the H.264/AVC

IV. Simulation Results.

H.264/AVC official reference software was used and hierarchical 16-QAM and AWGN channel model ware designed in MATLAB. The sequence known as "Suzie" which conform, to the Quarter Common Intermediate Format (QCIF) of spatial resolution 176× 144 pixels compressed to 42Kbit/s , was used and the transmitted signal was subject to Additive White Gaussion noise (AWGN) in the simulation work. The coded group of pictures (GOP) was length 9. In order to prohibit the temporal error propagation during transmission the I frame is inserted periodically every 9 frames.

Results are based on forty simulations performed with different AWGN seeds in order to obtain more reliable results .The PSNR is given by

$$PSNR = \frac{1}{40}\sum_{S=1}^{40} \text{PSNR}(S) \qquad (3)$$

Figure 6 demonstrates the PSNR performance of the received video data when convolutional coding is applied to both the HP and LP layers, when α is equal to 1.1, 1.3 in a 16-QAM system. Convolutional coding improves the quality of the video dramatically when α is equal1.3 improves, but only at low SNR values. This is due to the very bad error performance of the LP layer when increasing the value of alpha, as can be seen in Figure 2. Hence, non-uniform constellations, together with convolutional coding at both layers, improve the quality of service only at low SNR values. By increasing the value of α, the video quality improves, but only at low SNR values.

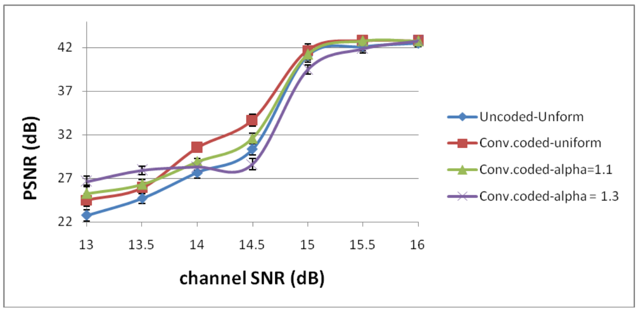

Figure 6 **PSNR vs. channel SNR, 16–QAM with Convolutional coding in both layers**

V. Conclusions and Future work.

The main objective of this paper was to study the UEP of H.264/AVC coded video transmission using non-uniform 16-QAM with convolution coding over an AWGN channel. We divided video data into HP data and LP data which are mapping in MSB and LSB position of 16-QAM constellation .The simulation results show that changing the value of alpha gives more protection to the HP channel at the expense of the LP channel. On the other hand, we can combine the UEP scheme with convolution coding in both channel to improve the overall PSNR. A Rayleigh fading channel model , higher degree of modulation (eg, 64 QAM) and also using other error control code to improve the quality of video, such as turbo coding will next be considered in future work.

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