Unequal Error protection of H.264/AVCvideo Using Hierarchical QAM

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Abstract- Unequal error protection (UEP) of H.264/AVC coded video is investigated using hierarchical quadrature amplitude modulation (HQAM), which takes into consideration the non-uniformly distributed importance of intracoded frame (I-frame) and predictive coded frame (P-frame) as well as the sensitivity of the coded bitsream against transmission errors. The HQAM constellation are used to give different degrees of error protection of the most important information of the video content. The performance of the transmission system is evaluated under additive Gaussion Noise (AWGN) .The simulation results indicate that the strategy produces a high quality of the reconstructed video data compared with uniform protection**.**

Key words: H.264/AV ,video coding ,hierarchical QAM, error protection

. I. INTRODUCTION

The growing demand in wireless communications has presented a new challenge in dealing with problems related to image and video transmission. 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. [2],[4] Several error resilient video coding techniques [1] have been proposed in order to minimize the effects of the transmission errors on the reconstructed video image quality. 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. [4] 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 [1],[3]. 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 [7] where NAL-A units constitute the HP bits while NAL-B and NAL-C units constitute the LP bits.

This paper presents the Unequal error protection (UEP) of H.264/AVC coded video using hierarchical 16-QAM , 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 16 –HQAM is given .Section 3 shows the proposed UEP and results are presentedinsection4.Conclusions and future work are given in section 5.

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II. Hierarchical 16-QAM

Hierarchical modulation were initially proposed to provide different classes of data to users in different wireless reception conditions [6],[8] The 16-QAM constellation naturally forms two different-integrity sub-channels Fig.1 show the constellation of 16-HQAM modulation , 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. 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.

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-HQAM with $\alpha > 1$,where alpha is the ratio of between the minimum distance between quadrants (d1) and minimum distance between points inside each quadrant (d2) and so is given by

$\alpha = d1/d2$ (1)

In this case the performance of the HP will be improved at the expense of LP. Consequently, Fig 2 shows the Symbol Error Rate of the high and low priority sub - channels in 16-HQAM when α is equal to 1, and for a Gaussian channel, the performance of the HP is seen to have only a small advantage over the LP sub-channel. However, by increasing the degree of non-uniformity,(d1 > d2) the improvement of the HP performance is significant, at the expense of the LP sub-channel

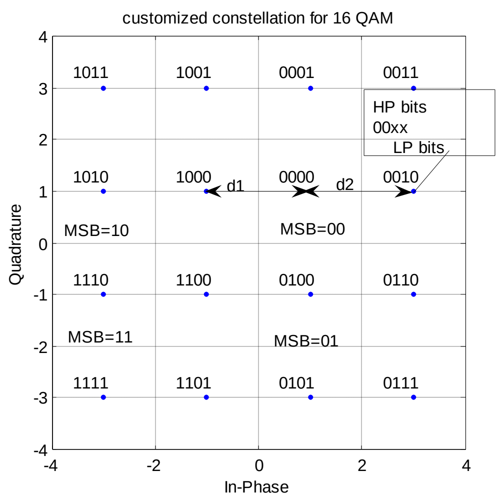

Fig 1.16-HQAM constellation diagram

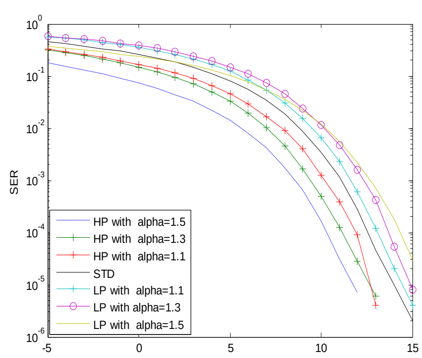

Fig2SERversus SNR for a range of alpha values for 16HQAM

III PROPOSED UEP USING 16-HQAM.

The system block diagram of the proposed UEP scheme is shown in Fig 3.. In this proposed scheme , the HP bits of theH.264/AVC coded video data are mapped to the MSB's of the modulation constellation points and the LP bits are mapped to LSB's of the hierarchical 16-QAM. Compared to the uniform error protection (UEP), in which the amount of protection allocated to the coded video sequence is uniformly distributed, the compressed video bit-stream, in our proposed UEP is divided into two classes of priority, namely HP data 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. Fig shows the group of pictures (GOP) , the first frame in a GOP which is an-I frame , is classified as HP data , while the last six frames which are P frames are classified as LP data and 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.

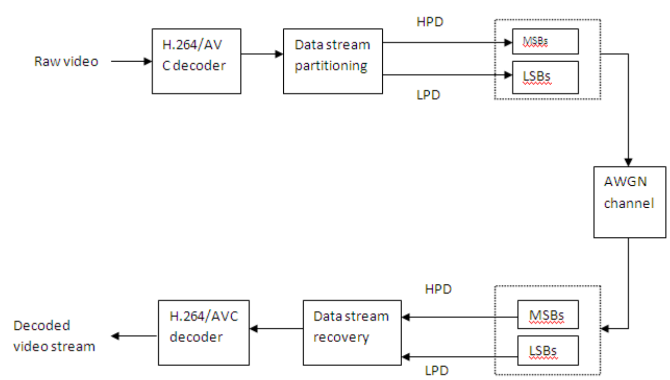

Fig 3 . Block diagram of the proposed UEP scheme

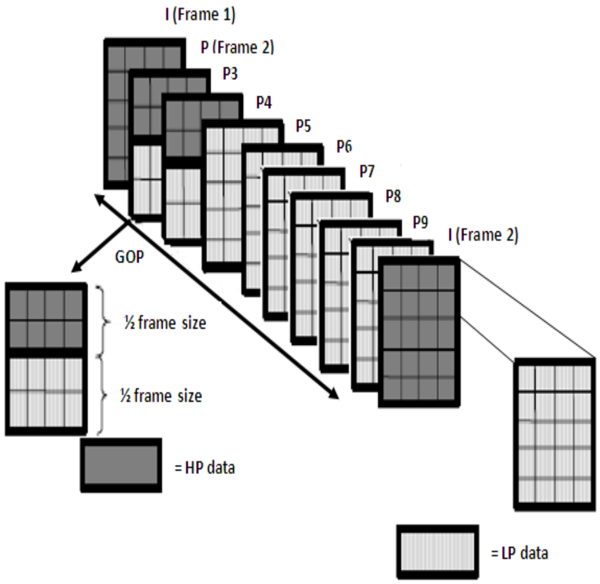

Fig 4 Proposed UEP of the H.264/AVC

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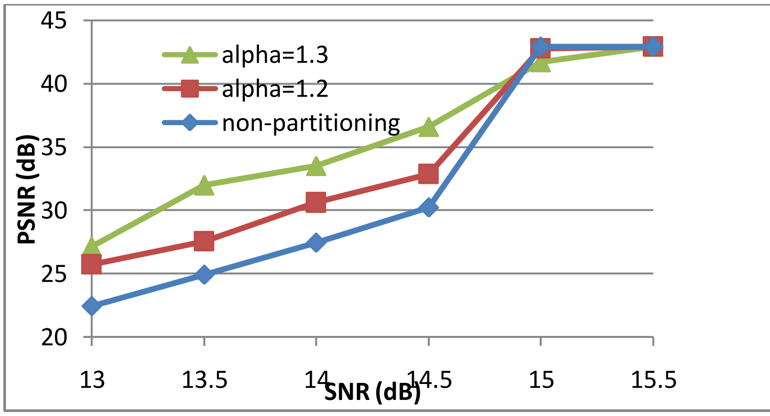

Fig 5 PSNR performance the UEP scheme for the Suzie video sequence

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

$$PSNR = \frac{1}{40} \sum_{S=1}^{40} \text{PSNR(S)} \qquad (2)$$

Fig 4 compares the PSNR performance of the HEP using hierarchical 16-QAM with non-partitioned 16QAM. It can be seen that in terms of PSNR the non-uniform 16QAM is better than uniform 16QAM. Fig 5 compares the PSNR versus alpha values of hierarchical 16-QAM for the range of channel SNR. It can be seen that low alpha values (alpha=1) result in highest PSNR at all SNRs.

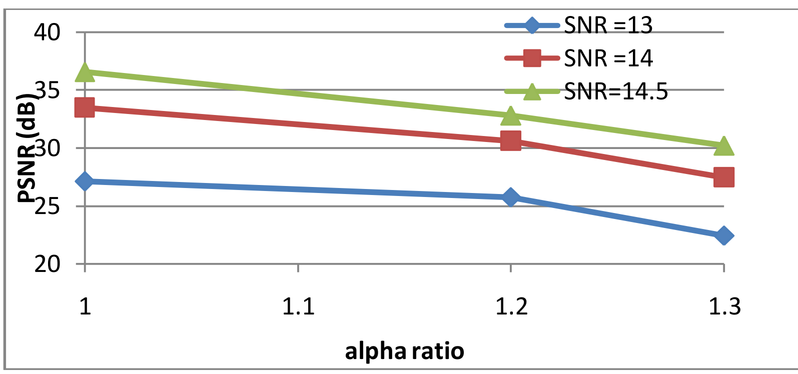

Fig. 6 PSNR performance for a range of alpha values for Suzie video sequence

V. Conclusions and Future work.

The main objective of this paper was to study the UEP of H.264/AVC coded video transmission using hierarchical 16-QAM over an AWGN channel .The two sub-channels HP and LP of the compressed data are transmitted using the MSBs and LSPs respectively . The simulation results show that changing the value of alpha gives more protection to the HP channel at the expense of the LP channel.

A Rayleigh fading channel model and higher degree of modulation (eg, 64 QAM) will next be considered in future work

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