Data Partitioning for the SPECK Coder for Real-Time Applications

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Abstract- *In this paper overview of error concealment scheme data partitioning of H.264/AVC and Set Partitioning Embedded Block (SPECK) coder is discussed. This paper refers to the reference software joint model 19(JM-19) for H.264/AVC. SPECK coder is a zero-block coder based on inter-subband correlation. In this paper, performance of H.264/AVC for various data partitioning conditions may be discussed.*

Keywords- Data partitioning, error concealment, error resilience, MDC, poly-phase sampling.

I. INTRODUCTION

Schematic of a typical video encoder is shown in Figure 1. The encoder changes the data into a compressed form proceeding to storage or transmission and the decoder converts the compacted or compressed form back into a representation of the original video data. The combination encoder/decoder pair is also called as a CODEC (enCOder/ DECoder) [1, 2].

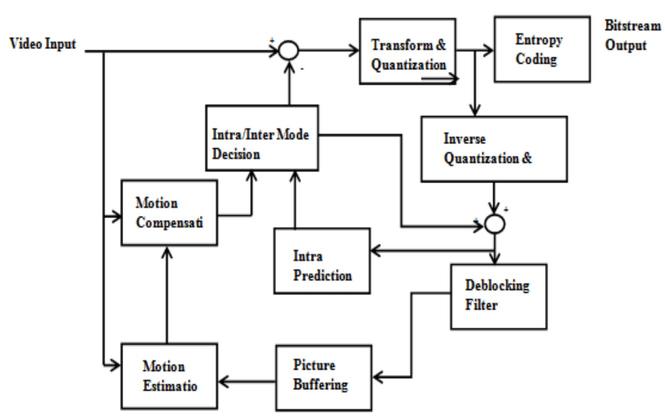

Fig. 1: Block diagram of H.264/AVC encoder.

The error resilience technique enables the compressed bit-stream to resist channel errors so that the impact on the reconstructed image quality should be as minimum as possible.

Error resilience takes nearly 20% of the consumption [3, 4].

II. ERROR RESILIENCY SCHEME

The H.264/AVC video coding standard explicitly defines all the syntax elements, such as motion vectors, block coefficients, picture numbers and the order they appear in the video bit stream. Syntax actually is the most important tool for ensuring compliance and error detection. Like other video coding standards, H.264/AVC [1] only defines the syntax of the decoder in order to allow flexibility in specific implementations at the encoder [5–7].

However ‘it provides no guarantees of end-to-end repro- duction quality, as it allows even crude encoding techniques to be considered conforming’ [8]. Basically a video bit stream corrupted by error(s) will incur syntax/semantics error(s). Due to the use of variable length coding (VLC), errors often propagate in the bit stream until they are detected. The syntax/semantics errors may include [9–12]:

(i) illegal value of syntax elements;
(ii) illegal sync header;
(iii) more than 16 coefficients are decoded in a 4×4 block;
(iv) an incorrect number of stuffing bits are found;
(v) this could also occur when extra bits remain after decoding all expected coefficients of the last coded block in a video packet;
(vi) Some of the coded blocks in a video packet cannot be decoded.

We have the following error resiliency scheme:
(1) Data partitioning
(2) Intra-block refreshing by rate distortion (R-D) control
(3) Flexible macroblock ordering (FMO)
(4) Redundant slices
(5) Arbitrary slice ordering (ASO).

Mainly in this paper we are concern with data partitioning.

III. ERROR CONCEALMENT SCHEMES

Error concealment is very important for an error resilient decoder. Typically, a decoder utilizes the spatial, spectral and/or temporal redundancies of the received video data to perform error concealment [13, 14]. Most error concealment schemes assume the pixel values to be smooth across the boundary of the lost and retained regions in spatial, spectral and/or temporal domains. To recover lost data with the smoothness assumption, interpolation or optimization based on certain objective functions is often used. The error-concealment schemes usually reconstruct the lost video data by making use of certain a prior knowledge about the video content. Chen and Chen [13] recently proposed an error concealment scheme:

$$\min_{dir\in\{top,bot,left,right\}} \arg \quad d_{sm} = \left\{ \sum_{j=1}^{N} \left| Y(\hat{mv}^{dir})_j^{IN} - Y_j^{OUT} \right| \; / N \right\}$$

where d_{sm} represents sum of absolute difference (SAD) difference between the pixels (of the luminance frame) from the boundaries of lost area and the neighboring boundaries of surrounding blocks [14]. Here Yˆ and Y represent the pixel values of the previous and current frame, respectively.

Poly-phase technique

Poly-phase sampling is an image transformation which transforms one image into four-based images, such as 1 to 4, 1 to 16 and so forth. The example shown in Figure 7 is to transfer one image into four images. Here, we take four pixels as a set, and mark them number 1 to number 4, respectively on every specific position and placing the pixels together which have the same number in the same frames [14].

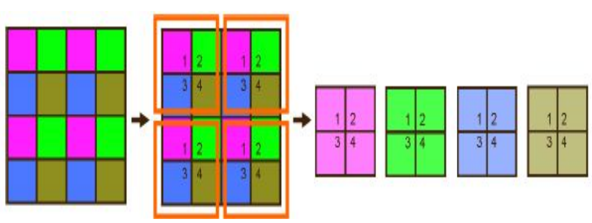

Fig. 2: Four pictures after poly-phase sampling [8].

IV. PROPOSED METHOD

After generating above four samples for a single image then each of them passes through the SPECK algorithm in different ways as shown in Figure 8. After the poly-phase sampling, all the descriptions passes through SPECK as LL band of all description named as D_{1LL} to D_{4LL} and the entire horizontal, vertical and diagonal tree as a separate descriptions as D_{1H} to D_{4H}, D_{1V} to D_{4V} and D_{1D} to D_{4D}, respectively.

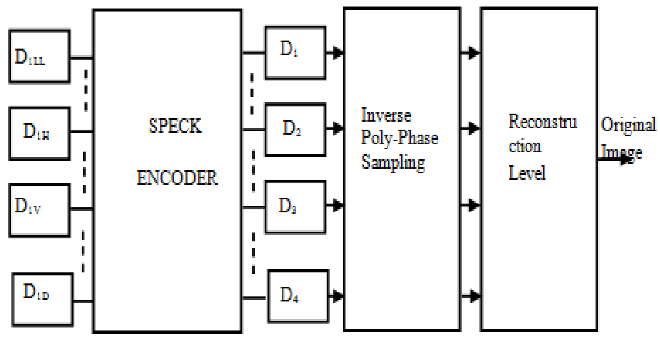

Fig.3: The block diagram of proposed method for decoding

V. SIMULATION, IMPLEMENTATION AND RESULTS

The software for video codec used in this work is reference software public joint test model encoder (JM-19) to generate H.264 results. This coder can accept input video of various formats and includes almost all options including that for advanced mode defined for H.264 standard.

The performance such as memory requirement and computational complexity of the proposed SPECK is evaluated and compared with original SPECK algorithm on angiography and acquisition sequence of rotational angiography image. The quality of the reconstructed image is measured in terms of the peak-signal-to-noise-ratio (PSNR). The rate distortion and other performances of proposed coder and original SPECK coder for ‘Acquisition sequence of rotational angiography’ image is shown.

Table 1: Details of the video sequence acquisition sequence of rotational angiography

S. No.	Details of Sequence	
1.	Name	Angiography
2.	Size	QCIF (176x144)
3.	Total size[byte]	3272399
4.	Frames	300
5.	Playing time[s]	10.03Min
6.	frame size[byte]	66
7.	Max frame size[byte]	23229
8.	Mean frame size[byte]	10871.76
9.	Mean bit rate[bit/s]	2609221.79
10.	Peak bit rate[bit/s]	6194400
11.	Mean I-frames[byte]	21828.46
12.	Mean P-frames[byte]	11272.43
13.	Mean B-frames[byte]	9297.14

Table 2: Performance when data partitioning is enabled with (different slice/frame) and without slices for video sequence acquisition sequence of rotational angiography

Bit error rate	YPSNR (dB)	YPSNR (dB)	YPSNR (dB)	YPSNR (dB)
	No slice	10 slice per frame	15 slice per frame	20 slice per frame
0.1	0	19.9	20	20.1
0.01	19.5	27.3	28	28.1
0.001	28	34.5	34.6	34.5
0.0001	37.2	36	35	34.7
0.00001	38.4	36.2	35.1	34.8

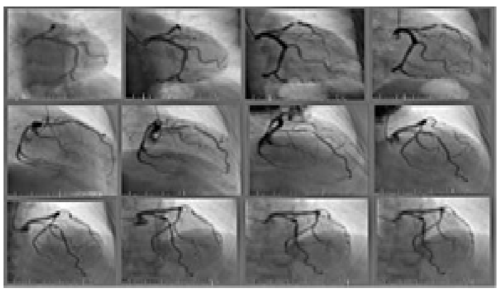

Fig. 4: Snapshot of 'Acquisition sequence of rotational angiography' video sequence, frame 252.

Table 3: BER vs. PSNR (dB) for video sequence acquisition sequence of rotational angiography

Sr. No.			
	BER	SPECK (Proposed)	SPECK
1	0	32.8598	36.5138
2	0.001	28.1524	30.6867
3	0.01	17.0245	16.3208
4	0.1	11.1035	7.9025

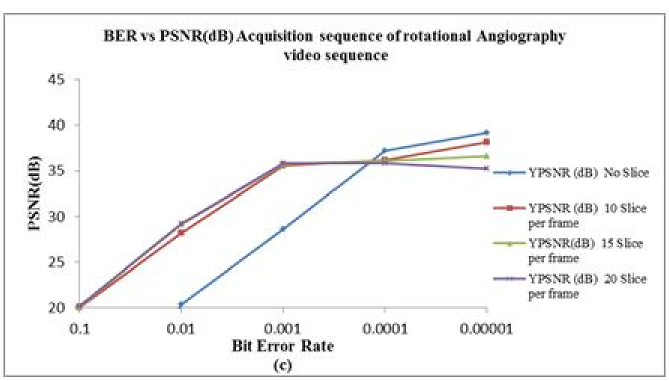

Fig. 5: Performance of proposed SPECK for video sequence mobile BER vs. PSNR (dB)

VI. CONCLUSION

Experimental result is presented to show the performance of data partitioning (DP) error concealment. For the error-free channel, the overheads introduced by the data partitioning degrade the PSNR of reconstructed sequences by 1–2 dB compared to the mode without error resiliency scheme. In spite of this, the simulation result also shows that the proposed method is more suitable for the higher bit error rate BER.

In real-time applications such as video conferencing or image transmissions in the present scenario, it is required to develop an efficient method to transmit for handheld devices. The simulation result shows that the performance of the proposed SPECK coder is better than original SPECK and also the constrained with hand-held/ portable multimedia devices such as processing power, power backup and memory capacity problem is considered. So to save the memory liner indexing method-based SPECK coder must be implemented which does not require static memory that is more suitable for real-time applications through wireless channels over portable devices.

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