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Error Resiliency for H.264/Advance Video Codec

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Abstract* - H.264/AVC is an international video coding standard, jointly developed by groups from ISO/IEC and ITU-T, which aims at achieving improved compression performance. Various applications of H.264/AVC include conversational, storage, and streaming. It also includes many advanced functionalities such as interactivities, scalabilities and Error resilience. The decoder is standardized by imposing restrictions on the bit stream and syntax, and defining the process of decoding syntax elements such that every decoder conforming to the standard will produce similar output when encoded bit stream is provided as input. It uses state of art coding tools and provides enhanced coding efficiency for a wide range of applications, including video telephony, real-time video conferencing, direct-broadcast TV (television), blue-ray disc, DVB (Digital video broadcast) broadcast, streaming video and others.. The paper proposes to investigate the decoder performance on different video quality measures. In this paper, we also discuss various error resiliency schemes employed by H.264/AVC.

Key words—Data Partitioning, Error concealment, Error resilience, Error Propagation, Mean square error

I. INTRODUCTION

Error resilience technique enables the compressed bit-stream to resist channel errors so that the impact on the reconstructed image quality is minimal. Error resilience takes nearly 20% of the consumption [1-4].Because; generally the Error Resilience schemes introduce some redundancy in the data. On the other hand compression schemes aim to remove various redundancies from the data. There are several parameters in H.264which we can find to be tuned so that a trade- off between compression rate and Error Resiliency can be made, aims different type of problems found in heterogeneous environments.

$$\text{Error Resiliency} \quad \alpha \quad \frac{1}{\textit{Compression}}$$

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 (Fig.1. shows a typical H.264/AVC video Encoder).

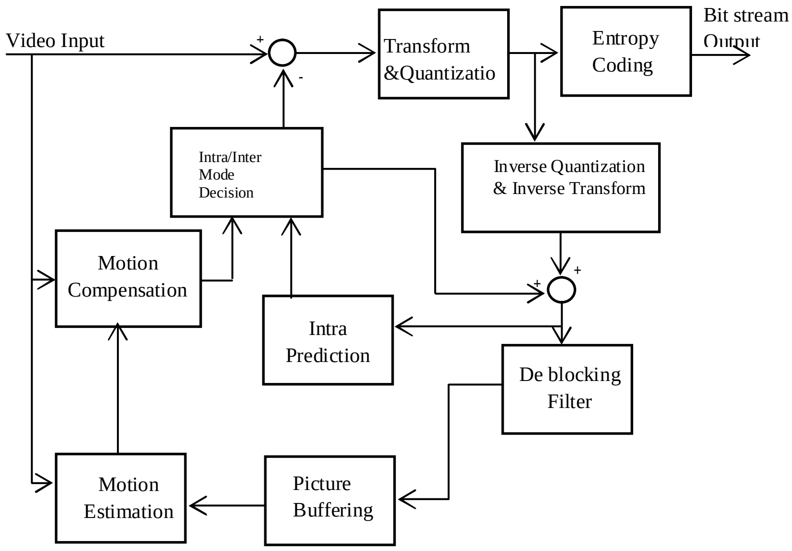


Fig.1. shows a typical H.264/AVC video Encoder

Syntax actually is the most important tool for ensuring compliance and error detection. Like other video coding standards, H.264/AVC [5-8] only defines the syntax of the decoder in order to allow flexibility in specific implementations at the encoder.

II. ERROR RESILIENCY SCHEME

However "it provides no guarantees of end-to-end reproduction quality, as it allows even crude encoding techniques to be considered conforming" [9-12]. 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.

We have the following Error Resiliency scheme;

1. *Data Partitioning*
2. *Intra-Block refreshing by Rate Distortion (R-D) Control*
3. *Flexible Macro block Ordering (FMO)*
4. *SP /SI Synchronization/Switching Frame*
5. *Arbitrary Slice Ordering (ASO)*

In this paper we discuss each scheme but Data Partitioning in detail.

III. DATA PARTITIONING

H.264/AVC has adopted a two layer structure design shown in Fig.:2;

- Video Coding Layer (VCL), which efficiently represents the video content.
- Network Abstraction Layer (NAL), which formats the VCL representation of the video and provides header information in a manner appropriate for conveyance by particular transport layers (such as Real Time Transport Protocol) or storage media.

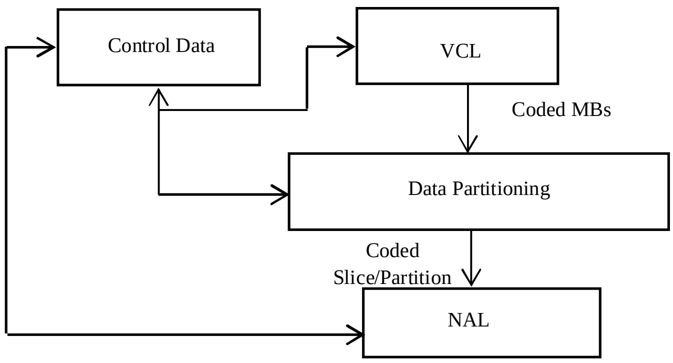


Fig.2. H.264/AVC Two Layered Structure Design

Where, VCL- Video Coding Layer
NAL- Network Abstraction Layer

Data partitioning enables unequal error protection (UEP) according to Syntax elements importance, since some syntax elements in the bit stream are more important than others [7]. The coded data that makes up a slice is placed in three separate Data partitions (A, B & C), each containing a subset of the coded slice. Each Partition can be placed in a separate NAL (Network Abstraction Layer) unit and may therefore be transported separately. Information regarding the Data partitioning is put into the slice header [13-18].

(i) Data Partitioning A

It contains header information (MB types, Quantization and MVs) with the loss of data. In DP A, data of the other two Partitions becomes useless.

(ii) Data Partitioning B

It contains Intra Constrained Baseline Profile (CBPs) and Transform coefficients of I-Blocks. The loss of this part will severely impairs the recovery of successive frames due to error propagation, because Intra frame and Intra MBs are used as references.

(iii) Data Partitioning C

It contains Inter CBPs and Coefficients of P-Blocks. Compared to DPA and DP B, the data contained in DP C is less important. However it is the biggest partition of a coded slice because a large number of frames are coded as P-frames.

(iv)Concealment in Data Partitioning

Error Concealment mechanism in Data partitioning have the following Available Partitions and their related Concealment method

1. Partitioning A& B Conceal using motion vectors from Partition A and texture from partition B; in this partition intra concealment is optional.
2. Partitioning A & C Conceal using motion vectors from Partition A and inter information from partition C; in this partition inter texture concealment is optional.

3. Partitioning A Conceal using motion vectors from Partition A.
4. Partitioning B & C Drop partitions B and C, use motion vectors of the spatially above MB row for each lost macro block. particular transport layers (such as Real Time Transport Protocol) or storage media.

IV. SIMULATION 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 H.264 decoder is implemented on the different video sequences and comparison is done based on different parameters. The parameters considered for comparison are MSE and PSNR.

1. PSNR: Peak Signal to Noise Ratio (PSNR) is measured on

$$MSE = \frac{1}{XY}\sum_{x=1}^{X}\sum_{y=1}^{Y}[i(x,y)-e(x,y)]^2 \ldots(3)$$

a logarithmic scale and depends on the mean squared error (MSE) of between an original and an impaired image or video frame.

$$PSNR = 10\log_{10}(\frac{255}{MSE})^2 = 20\log_{10}(\frac{255}{MSE})(for\,each\,Y,U,V)\ldots(2)$$

Where MSE is Mean square error MSE: The Mean Square Error measures the difference between the frames which is usually applied to Human Visual System. It is based on pixel-pixel comparison of the image frames. e(x,y) = intensity of output pixel(for each Y,U,V)

V. IMPLEMENTATION DETAILS

The different video inputs are considered for the experimentation. The sample result is displayed for further discussion.

Sequence title : Angiography
Resolution : 176x144
Number of frames : 300
Color space : YUV 4:2:0
Frames per Second : 30
Source : Uncompressed
Progressive

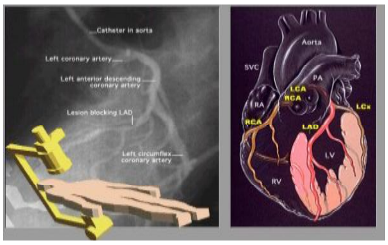


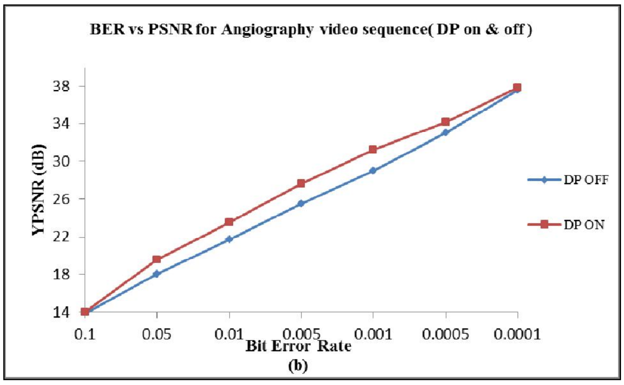
Fig.5. Snapshot of “Angiography” video sequence, frame 30

TABLE 1 PERFORMANCE OF DATA PARTITIONING (DP) ERROR RESILIENCY FOR VIDEO SEQUENCE ANGIOGRAPHY

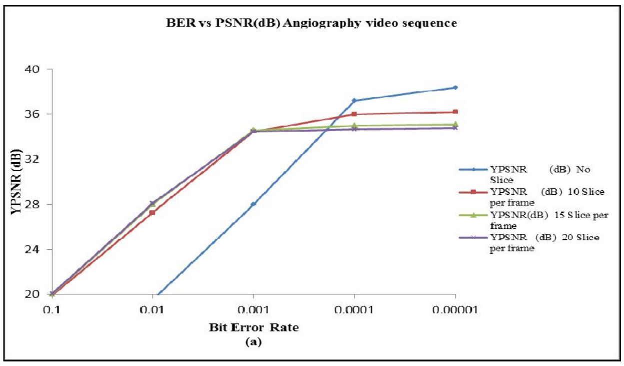
S.No.	Bit Error Rate	PSNR(dB)	PSNR(dB)
		DP OFF	DP ON
1	0.1	12.1	12.3
2	0.05	16.9	18.8
3	0.01	20	22.6
4	0.005	23.7	26.4
5	0.001	28.3	30
6	0.0005	31.9	32
7	0.0001	36.4	36.4

TABLE 2 PERFORMANCE WHEN DATA PARTITIONING IS ENABLED WITH (DIFFERENT NO. OF SLICE/FRAME) AND WITHOUT SLICES FOR VIDEO SEQUENCE ANGIOGRAPHY

S.No.	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
1	0.1	0	20	20.1	20.2
2	0.01	20.4	28.2	29.1	29.2
3	0.001	28.6	35.6	35.7	35.8
4	0.0001	37.2	36.2	36.1	35.8
5	0.00001	39.2	38.1	36.6	35.2



(a)



(b)

Fig.:6 Performance of Error resiliency for Angiography Video sequence

(a) With & without DP

(b) With (Different no. of slice per frame) and without slices for DP on

VI. DISCUSSION

Our goal in this paper was to review and discuss in detail the Data Partitioning and its effect for two format QCIF and CIF (Silent and Mobile sequence) for 300 frames. We plot the graph between Bit Error rate and Peak Signal to Noise ratio for Data Partitioning on and off and different number of Slice. These curves elaborate the performance of Error Concealment for two video sequences. We have also write Application Programming Interface (API) for Data Partition, which is basically explain the header file for Data Partition.

VII. CONCLUSION

The H.264/AVC video coding standard aims at achieving improved compression performance and a network-friendly video representation for different types of applications, such as conversational, storage, and streaming. In this paper, we described various error resiliency schemes, including a few non-normative error concealment schemes, employed by H.264/AVC. Experimental result is presented to show the performance of Data Partitioning (DP) Error Concealment. For error free channel, the overheads introduced by the Data Partitioning degrade the PSNR of reconstructed sequences by 1 to 2 dB compared to the mode without error resiliency scheme. The H.264 decoder is implemented on TMS320DM642. Parameters such as PSNR and MSE are calculated for the different video sequences on this processor. From tables, we can find MSE and PSNR for different Frame number .Quality of picture (PSNR) for Foreman video sequence is .2-.3 dB more than Salesman video sequence for same Frame number.

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