# Error Concealment of Data Partitioning for H.264/AVC

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## ABSTRACT

The H.264 is an international video coding standard developed by the ITU-T ISO/IEC Joint Video Team (JVT).This paper refers to the reference software joint model 4.2(JM-4.2).The H.264 standard is designed in two distinct layers Video Coding Layer (VCL) and a Network Abstraction Layer (NAL). Which aims at achieving improved compression performance and a network-friendly video representation for different types of applications, such as conversational, storage, and streaming? It includes many advanced functionalities such as interactivities, scalabilities and Error resilience. In this paper, we discuss Data Partitioning one of the error resiliency scheme employed by H.264/AVC. The related topics such as non-normative error concealment and network environment are also described. 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. Also Performance when Data Partitioning is enabled with (Different no. of slice/frame) and without slices is discussed.

*Keywords* - *Data Partitioning, Error concealment, Error resilience Error Propagation, Motion vectors.*

## I. INTRODUCTION

The outline block diagram of a codec is shown in Figure 1and schematic of a typical video encoder is shown in Figure 2. For video coding, a frame is divided into MBs of 16x16 pixels. For each MB, motion estimation finds the best match from the reference frame(s) by minimizing the difference between the current MB and from the reference frame. These residual MBs form a residual frame that is essentially the difference between the current frame and the corresponding motion compensated predicted frame. Simultaneously, motion vectors (MVs) are used to encode the locations of MBs that have been used to each MB in the current frame. The residual frame is then transformed through DCT or integer transform, and quantized.

Error resilience technique enable the compressed bitstream to resist channel errors so that the impact on the reconstructed image quality should be as minimum as possible.
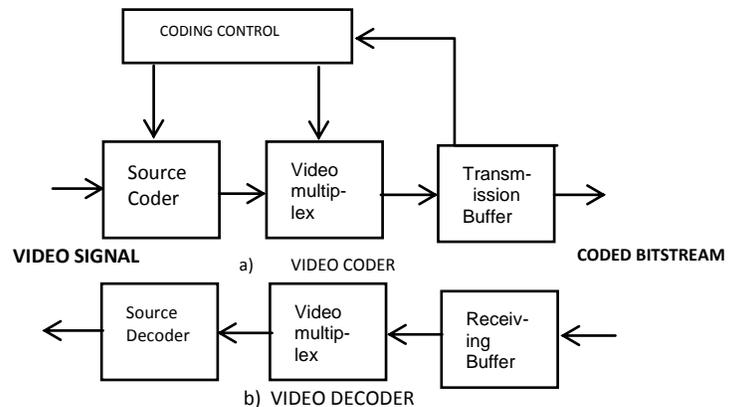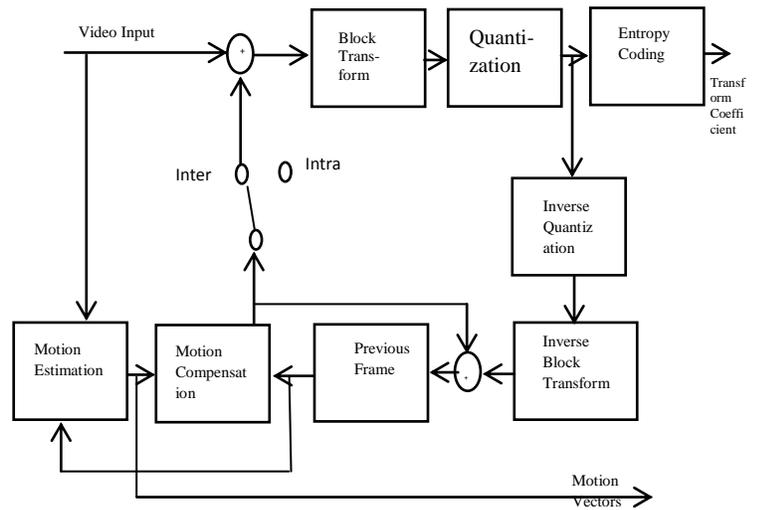


Figure-1: Outline block diagram of the Codec



Figure 2- Block Diagram of Typical Video Encoder

Error resilience takes nearly 20% of the consumption

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

Because, generally the Error Resilience schemes introduce some redundancy in the data[10]. On the other hand compression schemes aim to remove various redundancies from the data.

In H.264 there are many parameters that can be tuned so that a trade-off between compression rate and Error Resiliency can be made.

## 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 bitstream. 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.

However "it provides no guarantees of end-to-end repro-duction quality, as it allows even crude encoding techniques to be considered conforming" [2]. Basically a video bitstream corrupted by error(s) will incur syntax/semantics error(s). Due to the use of Variable length Coding (VLC), errors often propagate in the bitstream until they are detected. The syntax/semantics errors may include [3-5].

i) Illegal value of syntax elements.

ii) Illegal sync header.

iii) More than 16 coefficients are decoded in a 4x4 block.

iv) An incorrect number of stuffing bits are found.

   This could also occur when extra bits remain after Deco-ding all expected coefficients of the last coded block in a video packet.

v) 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.

DATA PARTITIONING

 H.264 has a two layer structure design shown in Figure 3 and an Abstract Level Flow Diagram is shown in Figure 4 ;

(i)Video Coding Layer (VCL), which efficiently represents the video content.

(ii) NAL formats the Video coding layer representation of the video and provides header information in such a manner appropriate for conveyance by particular transport layers or storage media.
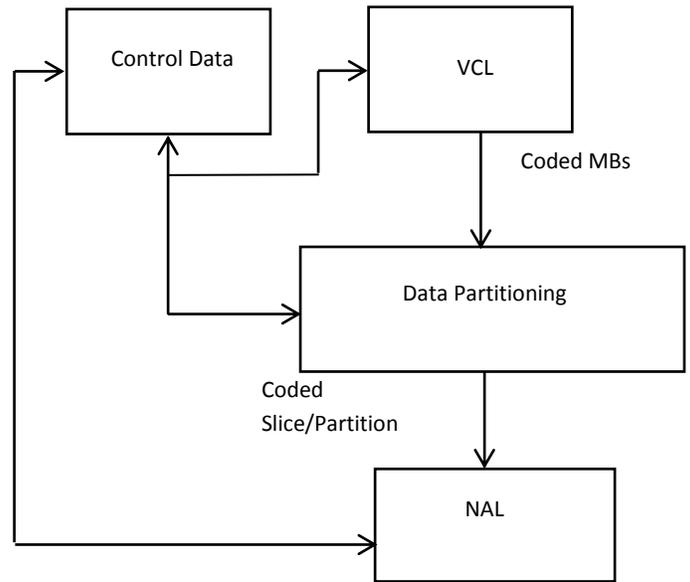


Figure3-H.264/AVC Two Layered Structure Design
   Where, VCL- Video Coding Layer
   NAL- Network Abstraction Layer

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.

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 Network Abstraction Layer unit and may therefore be transported

separately. Information regarding the Data partitioning is put into the slice header. [18]
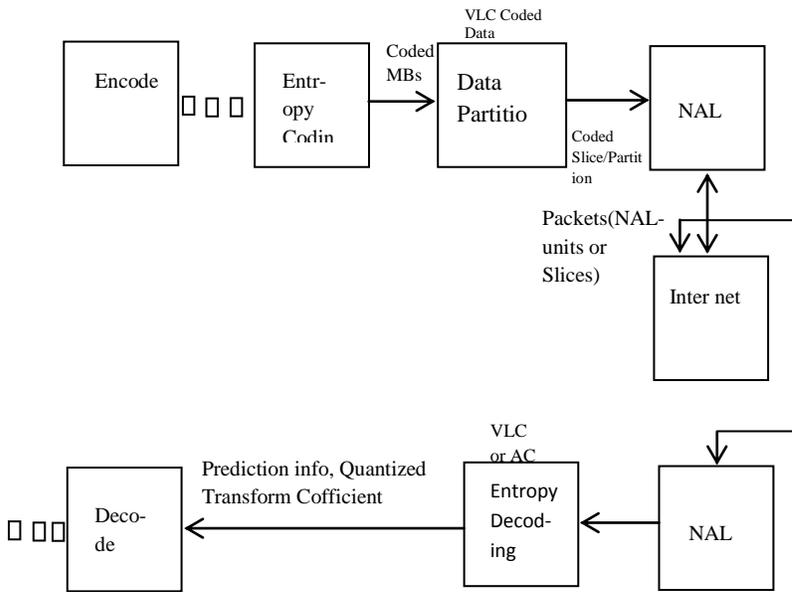


Figure 4- Abstract Level Flow Diagram

(i)      Data partitioning A

It contains header information (MB types, Quantization and MVs) with the loss of data. In data partitioning 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 MBs are used as references.

(iii)    Data partitioning C

It contains Inter Constrained Baseline Profiles and Coefficients of P-Blocks. Compared to Data Partition A and Data Partition B, the data contained in Data Partition 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

## 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 [13,16-18]. 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 [16] recently proposed an error concealment scheme, based on spatial smoothness, which builds prior knowledge by modeling the statistics of the video content explicitly, typically in the Region of Interest (ROI). Context based models are trained with the correctly received video data and then used to reload the lost video data. Trained models capture the statistics of the video content and thus reconstruct the lost video data better than reconstruction. which reduces the distortion across the edge while enforcing the smoothness along the edge. A strategy using a spatial activity criterion to efficiently combine several spatial interpolations to avoid the blur on edges. that the selected MV should result in the minimum luminance change across block boundary, when the corresponding block of the previous frame replaces the lost block of the current frame. The decision about selecting an MV, from amongst the MVs of the surrounding blocks, is based on the following equation [15].

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

Where, d sm represents SAD (Sum of Absolute Difference) difference between the pixels (of the luminance frame) from the boundaries of lost area and the neighboring boundaries of surrounding blocks [34]. Here Yˆ and Y represent the pixel values of the previous and current frame, respectively. The MVtop1 and MVtop2 are the MVs of two 8x8 blocks of the upper neighboring MBs. MVleft, MVright and MVbot are

MVs of the left, right and lower neighboring MBs, in that order.

## IV. ERROR CONCEALMENT OF H.264/AVC

Table-1: Error Concealment mechanism implemented by the decoder

| Available Partition(s) | Concealment method |
|---|---|
| A and B | Conceal using motion vectors (MVs) from Partition A and texture from partition B; Intra Concealment is optional. |
| A and C | Conceal using MVs from Partition A and inter information from partition C; Inter texture Concealment is optional. |
| A | Conceal using MVs from Partition A |
| B and C | Drop partitions B and C, use MVs of the spatially above MB row for each lost MB. |

Data Partitioning Application Programming Interface (API)

```
Encoder and Decoder both have the same
Data partition Structure
//!Data Partition
Typedef struct data partition
{
Bit Stream      *bit stream;
Encoding Environment   ee_cabac;
Int  (*write  syntax  element)(syntax
element*,struct data partition*);
/*!<virtual   function;actual   method
depend on chosen data partition and
entropy coding method*/
} Data Partition;
//!Slice
Type def struct
{
Data Partition *part arr; //!<array of
partitions-----
} Slice
#define MAX SLICE PER Picture 100
Typedef struct
{
Int no_slices;
Slice* slices [MAX SLICE PER PICTURE]
} Picture
```

## V. H.264/AVC RESULT OF DATA PARTITIOING (DP) ERROR ONCEALMENT
### SIMULATION RESULTS

Table-2: Performance of Data Partitioning (DP) Error Concealment for video sequence Salesman (QCIF)

| S.No. | Bit Error Rate | YPSNR (dB) for DP OFF | YPSNR (dB) for DP ON |
|---|---|---|---|
| 1. | 0.1 | 13.8 | 14 |
| 2. | 0.05 | 18 | 19.6 |
| 3. | 0.01 | 21.7 | 23.5 |
| 4. | 0.005 | 25 | 27.6 |
| 5. | 0.001 | 29 | 31.2 |
| 6. | 0.0005 | 33 | 34.1 |
| 7. | 0.0001 | 37.6 | 37.8 |

Table-3: Performance when Data Partitioning is enabled with (Different no. of slice/frame) and without slices for video sequence Salesman (QCIF)

| S.No. | Bit Error Rate | YPSNR (dB) No Slice | YPSNR (dB) 10 Slice per frame | YPSNR (dB) 15 Slice per frame | YPSNR (dB) 20 Slice per frame |
|---|---|---|---|---|---|
| 1 | 0.1 | 0 | 19.9 | 20 | 20.1 |
| 2 | 0.01 | 19.5 | 27.3 | 28 | 28.1 |
| 3 | 0.001 | 28 | 34.5 | 34.6 | 34.5 |
| 4 | 0.0001 | 37.2 | 36 | 35 | 34.7 |
| 5 | 0.00001 | 38.4 | 36.2 | 35.1 | 34.8 |

Figure 5 shows the Salesman video sequence used in the analysis;
Detail of the sequence
Name - Salesman
Size - QCIF (176x144)
Frame rate - 7.5 fps
Bit rate - 64 Kbps
No. of frames -100

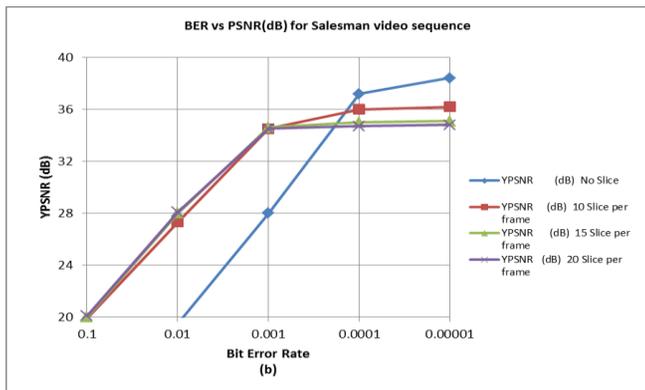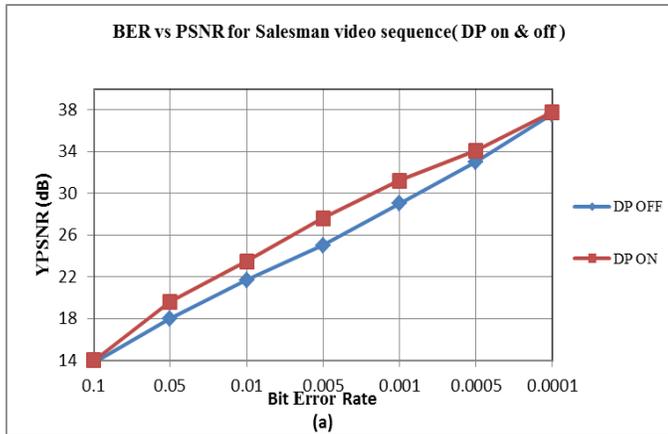Figure 5: Snapshot of "Salesman" video sequence



Figure 6 - Performance of Error Concealment for Salesman Video sequence (a) With & without DP (b) With (Different no. of slice per frame) and without slices for DP on

## VI.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 list 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.

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