Error Concealment for MPEG-4 Part 10 Video Codec

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Abstract
MPEG-4 PART 10 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 MPEG-4 PART 10 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, directbroadcast TV (television), blue-ray disc, DVB (Digital video broadcast) broadcast, streaming video and others. The paper also proposes to analyze and compare Video Quality Metrics for different encoded video sequences. The paper proposes to investigate the decoder performance on different video quality measures. The Error concealment scheme of Data Partitioning (application programming interface) is also discussed.

Keywords
Data Partitioning, Error concealment, Mean Square Error, Error Resilience, Error Propagation

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]. 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.264 which 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.

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

The MPEG-4 PART 10 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 (Fig.1. shows a typical MPEG-4 PART 10 video Encoder).

Syntax actually is the most important tool for ensuring compliance and error detection. Like other video coding standards, MPEG-4 PART 10 [2] only defines the syntax of the decoder in order to allow flexibility in specific implementations at the encoder.

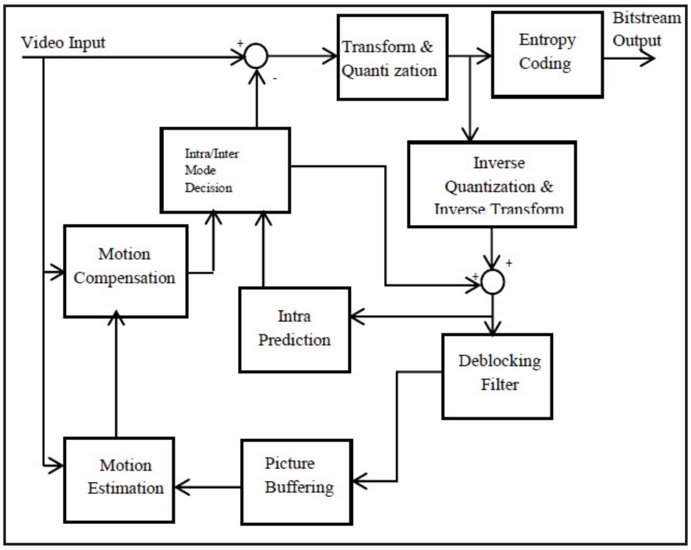


Fig. 1: Shows a Typical MPEG-4 PART 10 Video Encoder

II. 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 [3-6]. 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 [6-8]. The errorconcealment schemes usually reconstruct the lost video data by making use of certain a prior knowledge about the video content. Chen and Chen [9] 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. Lam, Reibman and Liu [9] proposed a Boundary Matching Algorithm (BMA) to estimate lost motion vectors. Yan and Ng [10, 13] presented a Selective Motion Vector Matching (SMVM) algorithm for MV recovery, which incorporates the status flags of the neighboring pixels of the missing block(s) and constructs new MV sets for block matching. Zheng and Chau [10] used the Lagrange interpolation formula to constitute a polynomial that describes the motion tendency of MVs, which are next to the lost MV.
The specific schemes suggested for the MPEG-4 PART 10 standard in [11-14] involve intra and inter picture interpolations. These two concealment schemes can, in fact, be used as benchmarks to evaluate other error concealment schemes.

MV interpolation exploits the close correlation between the lost block and its spatial neighbors.
Since, the motion of a small area is usually consistent, it is reasonable to predict the MV of a block from MVs of its neighboring blocks. However, the median or averaging over all neighbors' MVs does not necessarily give better results [14]. Therefore, the motion activity of the properly received slice is first computed. If the average motion is less than a threshold (i.e., 1/4 pixel), the lost block will be concealed by directly copying the colocated block from the reference frame; otherwise the MV recovery is done using the procedure shown [14]. Note 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:

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

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 [10].
Here Yˆ and Y represent the pixel values of the previous and current frame, respectively. The MVtop1 and $MVtop_2$ 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. The motion of an 8x8 block is calculated as the average of the motion of the spatially corresponding 4x4 or other shaped (e.g. 4x8) blocks. The selected MV gives the smoothest boundary transition.
The error concealment schemes introduced above are decoderbased. If a feedback channel is available, a decoder can request the encoder to send out the lost data (or the data in the error propagation region) for error concealment. A few error concealment schemes based on the encoder and decoder interaction have been discussed in [15-19].

```
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
```

Fig. 2: Data Partitioning Application Programming Interface

III. 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.

A. PSNR

Peak Signal to Noise Ratio (PSNR) is measured on a logarithmic scale and depends on the Mean Squared Error (MSE) of between an original and an impaired image or video frame.

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

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.

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

e(x,y) = intensity of output pixel(for each Y,U,V)

IV. Implementation Details

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

Sequence Title : Acquisition sequence of rotational angiography
Resolution: High Definition : 1280× 720
Number of frames : 252

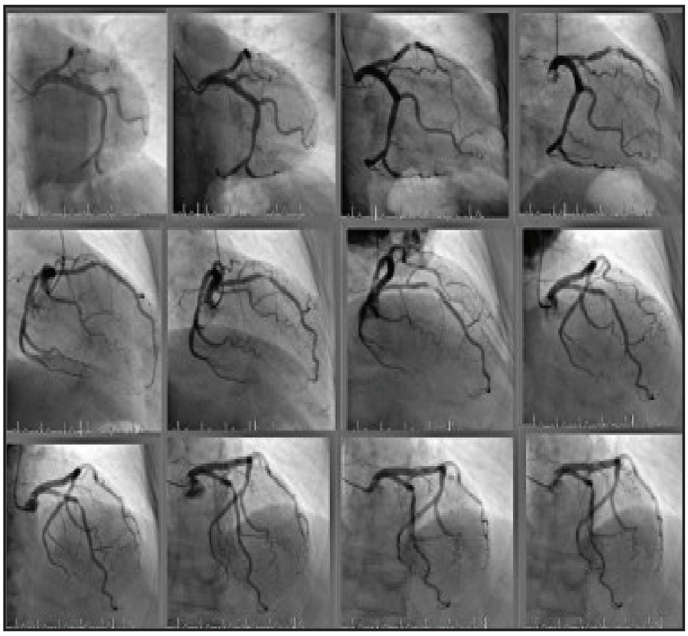


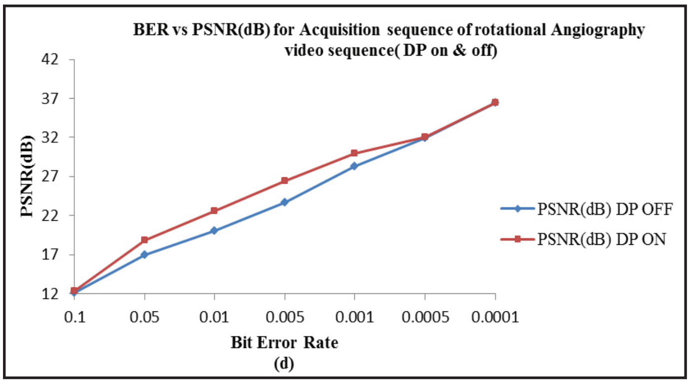
Fig. 3: Snapshot of “Acquisition Sequence of Rotational Angiography” Video Sequence, Frame 252

Table 1: Performance of Data Partitioning (DP) Error Concealment For Video Sequence of "Acquisition Sequence of Rotational Angiography" Video Sequence

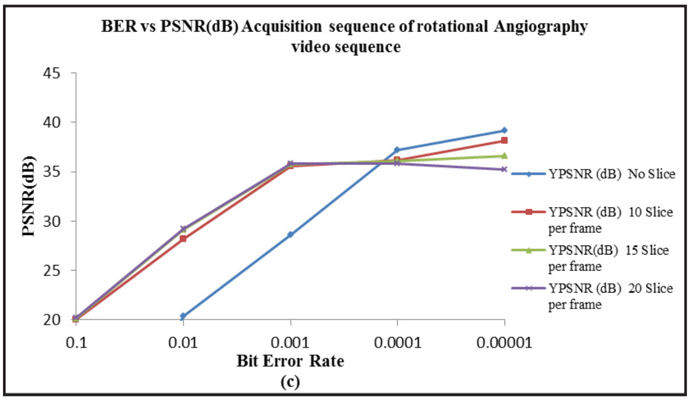
S.No.	Bit Error Rate	PSNR(dB)	PSNR(dB)
		DP OFF	DP ON
1.	0.1	13.8	14
2.	0.05	18	19.6
3.	0.01	21.7	23.5
4.	0.005	25	27.6
5.	0.001	29	31.2
6.	0.0005	33	34.1
7.	0.0001	37.6	37.8

Table 2: Performance When Data Partitioning is Enabled With (Different No. of Slice/Frame) and Without Slices for "Acquisition Sequence of Rotational Angiography" Video Sequence

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. 4: Performance of Error Concealment for Silent & Mobile Video sequence (a) With & Without DP (b) With (Different no. of Slice Per Frame) and Without Slices for DP on

V. Discussion

Our goal in this paper was to review and discuss in detail the Data Partitioning and its effect for a video sequence. 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 a video sequence.

We have also write Application Programming Interface (API) for Data Partition, which is basically explain the header file for Data Partition.

VI. Conclusion

The MPEG-4 PART 10 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 concealment schemes, employed by MPEG-4 Part 10. 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.

From tables, we can find MSE and PSNR for different Frame number. Quality of picture (PSNR) for of "Acquisition sequence of rotational angiography" video sequence, frame 252 video sequence is .2-.3 dB more.

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