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A Study on the Effects of Macro Block Size used in Error Resilient Transmission Techniques

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Abstract

In the world of internet, transmission of images and videos are about more than 80% percentage of total data transmission. During the transmission data loss is experienced due to various reasons. To reduce the impact of data loss, error resilient transmission techniques are used during important data transfer between geographically distant machines. In order to achieve error resilience, different strategies and techniques are adopted. Certain techniques use more than one channel for transmitting the data. The data is sent in multiple channels in an interleaved fashion so that the missing channel data may be predicted or estimated from the available channel information. Video streaming is one of the popular application which use error resilient techniques. The video contains both spatial and temporal data. The spatial data is taken as a block of data like a grid and are processed before transferring. Normally the blocks are in a square or in rectangular form. The size of the block is also varies to the techniques adopted. Here a study on the effect of these blocks size in terms of quality and computation time is proposed. Based on the observation made by the study a better size of the macro block is reported.

Keywords: Error resilience, Video coding.

INTRODUCTION

The channel failure and network congestions are the common reason for data loss while transmission. The loss in data is critical in certain application areas. Especially medical images carry vital information for diagnosis by the physician who sits at the remote end from the actual patient. Remotely assisted surgery is also carried out by physicians, here live video streaming is carried out and should be error free and accurate. In such scenario the error resilient transmission becomes vital. Various error resilient techniques are designed and used in practical. Each method has its own advantages and disadvantages.

Some of the popular methods proposed by scientists for error resilient transmission are given in this section. I.E.G. Richardson and M.J. Riley presented a layered coding method in which MPEG encoded video frame is split into layers according to the category of each coded image. Analysed the tolerance of each layer to bit error rate property and conclude that each layer can tolerate diverse error rates. Applying diverse levels of Forward Error Correction (FEC) to each layer it is possible to guarantee reliable transmission even as minimising the overhead due to FEC.

Hung-Jyh Chiou, Yuh-Ruey Lee, Chia-Wen Lin presented a two-pass intra-refresh transcoding method [2] for incorporating error-resilience features to a compressed video at the media gateway of a three-tier streaming system. The transcoder adaptively vary the intra-refresh rate based on the video content and the channels packet-loss rate to protect the important macroblocks (MBs) from packet loss. The encoder estimates the amount of error propagation at MB level, and then generates side information as transcoding hints for use at the transcoder during the first-pass. In the second-pass transcoding, the error-resilient transcoder adaptively determines the intra-refresh rate and the locations of MBs to perform intra-refresh according to the side information. Experimental results show that the proposed method can effectively mitigate the error propagation due to packet loss so as to improve the visual quality significantly.

Li-Wei Kang, a,b Jin-Jang Leou proposed a scheme [3]to recover high-quality JPEG images from the corresponding corrupted images. At the encoder, the important data (the codebook index) for each Y (U or V) block in a JPEG image are extracted and embedded into another ‘‘masking’’ Y (U or V) block in the image by the odd–even data embedding scheme. At the decoder, after all the corrupted blocks within a JPEG image are detected and located, if the codebook index for a corrupted block can be correctly extracted from the corresponding ‘‘masking’’ block, the extracted codebook index will be used to conceal the corrupted block; otherwise, the side-match VQ technique is employed to conceal the corrupted block.

Chih-Ming Fu , Wen-Liang Hwang , Chung-Lin Huang , propose an analytical rate-distortion optimized joint source and channel coding algorithm [4]for error-resilient scalable encoded video for lossy transmission.

A video is encoded into multiple independent substreams to avoid error propagation and is assigned forward error correction (FEC) codes and source bits using Lagrange optimization, separates video coding and packetization into different tiers which can be easily incorporated into any coding structure that generates a set of independent compressed bit-streams [5]. Firstly, with the help of the SSE-based rate-distortion optimization (RDO), present a low complexity Lagrange multiplier decision method for the SSIM-based RDO video coding in the error-free environment. Then, the SSIM-based decoding distortion of the user end is estimated at the encoder and is correspondingly introduced into the RDO to involve the transmission induced distortion into the encoding process. Further, the Lagrange multiplier is theoretically derived to optimize the encoding mode selection in the error resilient RDO process.

Video transmission based on data embedding is proposed [6]. At the encoder, for an H.26L intra-coded I frame, the important data for each macroblock are extracted and embedded into another macroblock(s) within the I frame and the next P frame by the proposed odd–even data embedding scheme. For an H.26L inter-coded P frame, the important data for each slice are extracted and embedded into the next frame by the proposed slice-based embedding scheme for P frames. At the decoder, for each corrupted macroblock, if the important data for a corrupted macroblock can be correctly extracted, the extracted important data will facilitate the employed error concealment scheme to conceal the corrupted macroblock. Otherwise, the employed error concealment scheme is used to conceal the corrupted macroblock.

Apart from the typical error- resilient transmission algorithms, the algorithm [7] proposed by Kya-Chan Roh and others provides a better image quality with a little overhead. This tool partitions the quantized DCT coefficient into an even - value approximation and odd remainder part. This proves better over an error prone environment.

Fang Yong, Wu Chengke , LI Bo and Wang Yangli [8]have proposed a different approach called as bi -directional error-resilient entropy coding [BEREC]. BEREC groups two blocks into one block-pair and places in one fixed block length slot, and employs a searching strategy. The two blocks are able to be decoded in forward and backward directions.

Sungdae Chao and William A. Pearlman proposed 3-D spatial and temporal tree preserved SPIHT algorithm [9] for error resilient compression and transmission of scalable video. This technique breaks to wavelet transform into a number of spatio – temporal tree blocks that can be encoded and decoded independently.

Wei Xiang Histoam has proposed two alternative error resilient scheme [10]for multi-view video transmission based on WZ encoding technique. The light weight- encoder and complex-encoder are used to distribute the encoding operation and all the complicated temporal and interview correlation exploration process is done at decoder side.

Video transmission over error-prone channels, are made possible using an error resilient video coding algorithm termed as Z-FMO [11]. This algorithm partitions a picture into slice groups and a intra-frame prediction is performed in spatial domain. Moreover error resilience is achieved by including the neighbour macroblock to some slice group.

Chia-Hung yeh and others have proposed a reversible data embedding technology [12] for Scalable Video Coding (SVC). At times errors are propagated to other frame that is lower layer to upper layers. The algorithm embeds the required information of lower layer in its upper layer to improve visual quality, this is utilized when frames in lower layer are lost.

PROPOSED STUDY

Even though various strategies are used by researchers on error resilience, the proposed work focuses on the effect of block size in error resilient data transmission. The study planned to use different scenarios for the analysis by varying the block size used for transmission and to simulate different settings for data transmission and data loss. The study considers four simulated channels for transmission. The scenario of channel disconnection and channel disruption are also simulated. The received data are used to reconstruct the original image or data transmitted. Since the channel data are interleaved before transmission the lost data are replaced from the neighbouring locations. Then the quality of reconstructed image is measured. Similarly instead of replacing neighbouring data the lost data is estimated by interpolating neighbouring data then the quality of the reconstructed image is measured. The quality metrics computed are PSNR(Peak Signal to Noise Ratio), MSE(Mean Square Error), SSIM (Structured Similarity) and CWSSIM (Complex Wavelet Structured Similarity). The various block size considered for simulations are 8x8 to 4x4x4 and 16x16 to 4x8x8. The algorithm considers The other block sizes are not considered considering that very small block size would lead to reduced compression ratio and generate more blocks even though results in good quality. Whereas the larger block size would lead to unacceptable very poor quality of image even though higher compression ratio.

The methods mentioned in the article is related to scenarios planned for the analysis are

1. Tile 8x8 macro Block with 4x4x4 Sub-blocks (Replace)
2. Interleaved -8x8 to 4x4x4 Method(Interpolate)
3. Interleaved -16x16 to 4x8x8 Method(Predict)
4. Interleaved -16x16 to 4x8x8 Method(Replace)

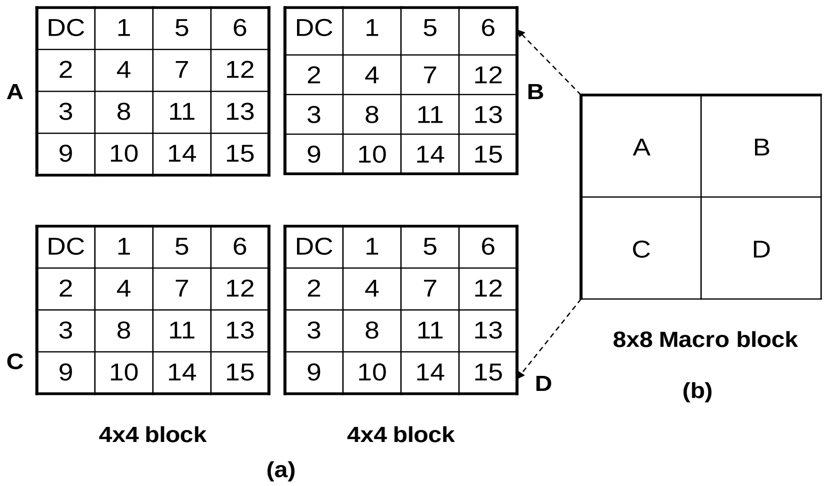


Figure 1. 8x8 Macro block into four 4x4 sub blocks

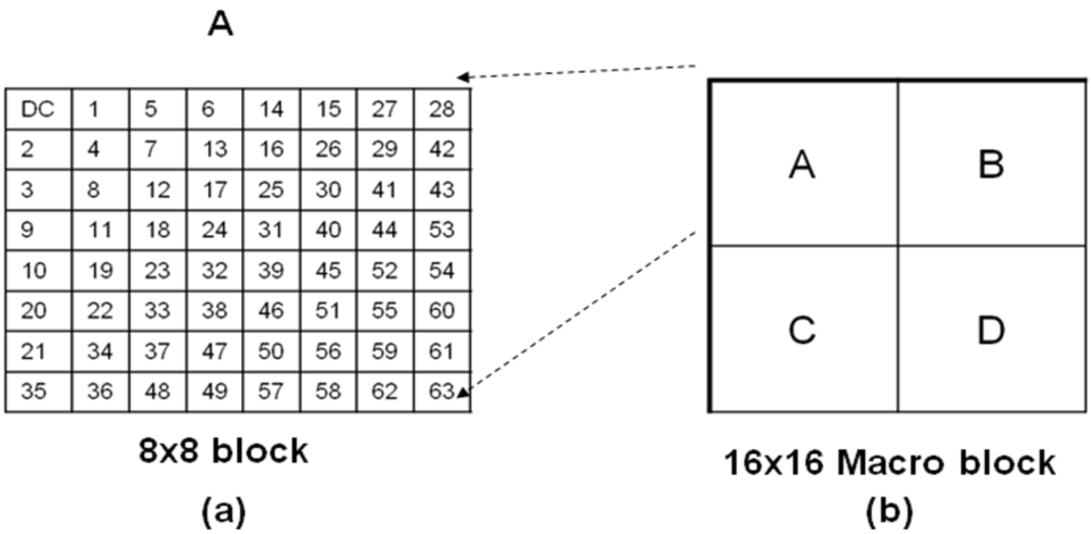


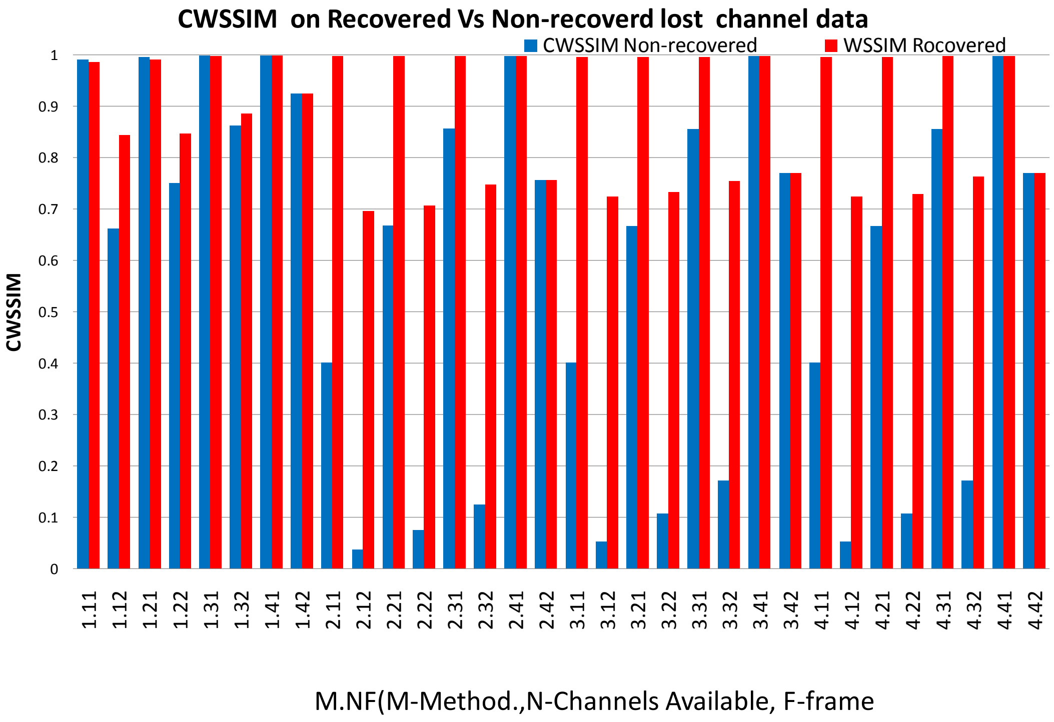
Figure 2. 16x16 Macro block into four 8x8 sub blocks

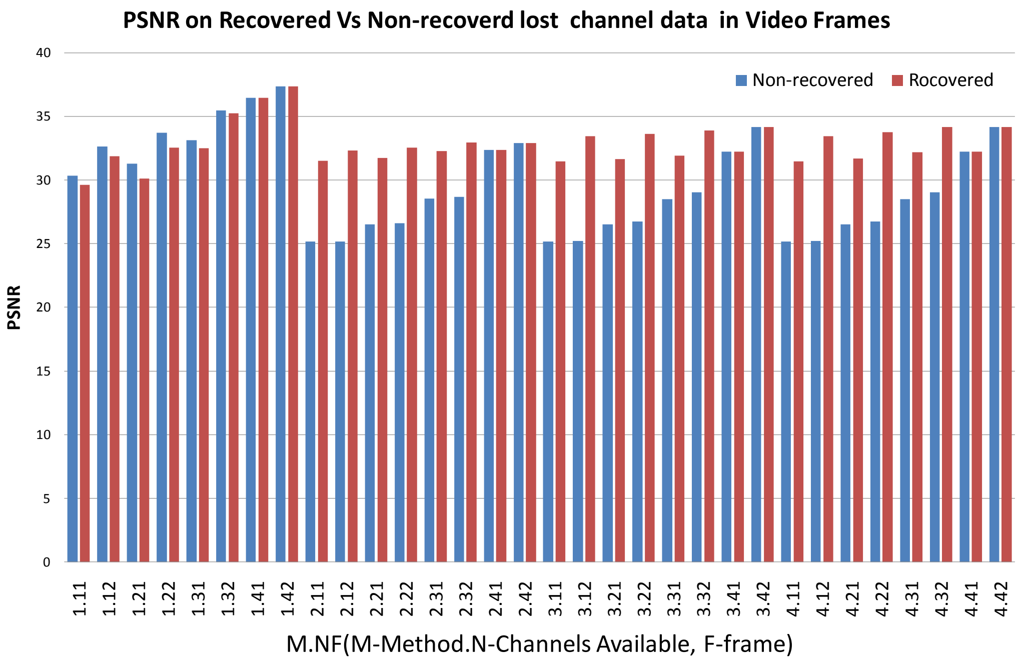
In the first and second methods the macro block of size 8x8 is used. The macro blocks are further divided into four 4x4 sub blocks. DCT is applied to each sub block. The DC coefficients are duplicated and transmitted through all the four channels where no duplication is on the AC coefficients. Since DC coefficients are having the average detail of the block, even if three of the four channels are lost, it is possible to reconstruct the lost blocks approximately using the DC coefficient received from the available channel data.

In the first method the AC coefficients are not interleaved so the AC coefficients received from the available channel is duplicated for reconstructing the lost blocks, where as in the second method the AC coefficients are interleaved so the lost AC coefficients are estimated from the received interleaved AC coefficients from the available channel data.

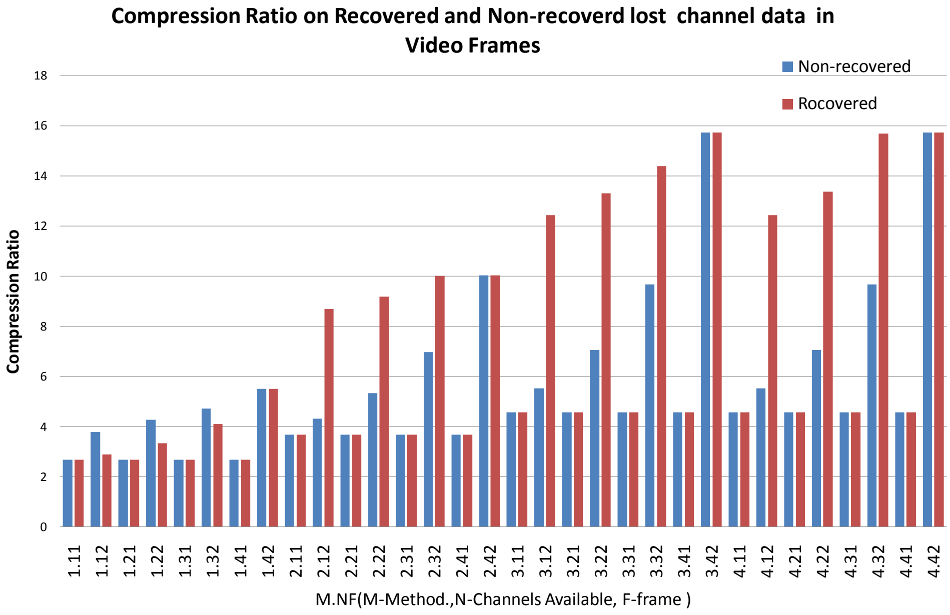
In the third and fourth methods the macro block of size 16x16 is used. The macro blocks are divided into four 8x8 sub blocks. DCT is applied to each sub blocks as usual. Then the DC coefficients are duplicated and transmitted through all the four channels. As in the previous case no AC coefficients are duplicated for transmission. Here also even if three of the four channels are lost, it is possible to reconstruct the lost blocks approximately using the DC coefficients received from the available channel. Similar to the process performed on 4x4 sub blocks in first and second methods the AC coefficients are processed in third and fourth methods respectively.

The experimental results are tabulated and analysed with charts and statistical measures. The quality of the reconstructed image is measured in comparison with the original image. The measure SSIM is computed according to equation (1). In which I represents the original image and R represents the reconstructed image. PSNR , CWSSIM are computed according to equations (2) and (3) respectively.

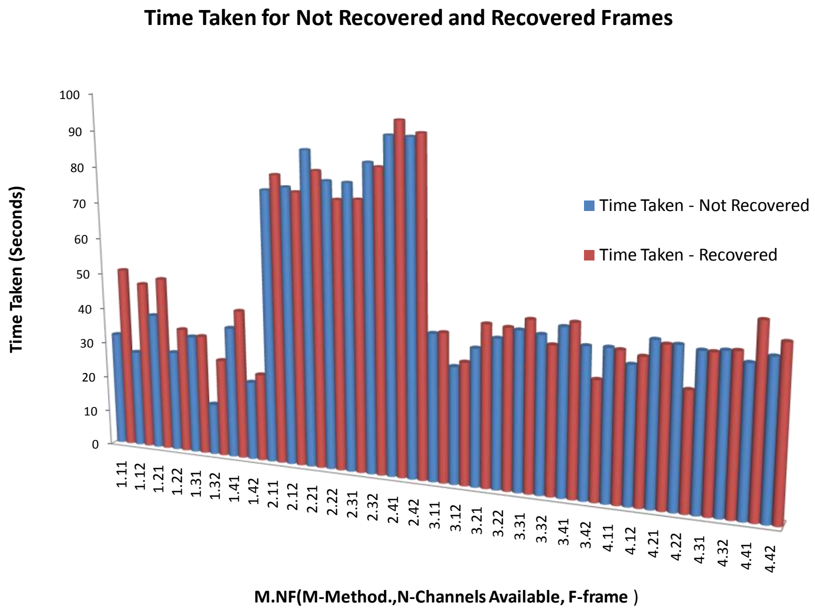




The compression rate achieved in each scenario is also observed and analysed. The chart in figure gives the glimse of bit rate required for the transmision which is inversly proportional to the compression ratio.



The time require for entire process for different scenario is also taken into consideration for the study.



The observation reveals the fact those method-1 gives attractive values for two of the features that are lesser computation time and higher quality. Method 3 also has two attractive features that are higher compression ratio and high quality. Method 4 gives the desirable feature values that are highest compression ratio and high quality reconstructed image with Medium computation time.

Feature	**Method**			
	1	**2**	**3**	**4**
Computation Time	Less	High	Medium	Medium
Compression Ratio	Less	Medium	Higher	Highest
Quality	Higher	Medium	High	High

CONCLUSION

This paper presented a study on the effects of macro block size used for data transmission, for which methods used four different block sizes for the analysis. The observation leads to a conclusion that there is a trade off between computation time, quality and compression ratio. In general the macro block size of 16 x 16 and four 8x8 sub-block combination gives a desirable solution.

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