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Error-Concealment Techniques Using FEC Interpolation for BMP & DIB Format

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Abstract -This paper introduces a new framework for error concealment in block-based image coding systems. Unlike previous approaches that simultaneously recover the pixels inside a missing block. We propose to recover them in a sequential fashion such that the previously-recovered pixels can be used in the recovery process afterwards. The principal advantage of the sequential approach is the improved capability of recovering important image features brought by the reduction in the of statistical modeling, i.e. from block wise to pixel wise. Under the framework of sequential recovery, we present an forward error concealment interpolation scheme derived from the pixel wise statistical model. We also investigate the problem of error propagation with recovery and propose a boundary matching strategy to alleviate it. Extensive experiment results are used to demonstrate the improvement of the proposed forward error-concealment technique over previous techniques in the literature.

***Index Terms*—Forward error concealment Interpolation, Scanning error detection.**

I. INTRODUCTION

We shall assume that the locations of corrupted blocks are known before error concealment is employed at the receiver. Such information can be obtained either at the transport decoder or at the source decoder [11]. The performance of any error-concealment technique depends on the accuracy of the model used to characterize the image source in a variety of block-loss situations. Most existing error-concealment techniques [3]–[14] employ block wise deterministic models in either the spatial or the spectral domain to describe the spatial dependency within images. References [3], [6] estimate the lost discrete cosine transform (DCT) coefficients in the spectral domain based on the spatial smoothing constraint on the reconstructed blocks. Simplified edge models are imposed in [5], [7], [9], and [14] to derive directional interpolation in the spatial domain. Other approaches include fuzzy logic reasoning [8], best neighbor matching [10], maximally smooth recovery [12], and projection-onto-Convex-set (POCS) [4], [13]. All those techniques simultaneously recover the pixels inside the missing block, which we call *parallel recovery*. In this paper, we present a new framework for error-concealment techniques: *error recovery*. The image data in the corrupted block are recovered in a sequential fashion such that the recovery relies on not only successfully received pixels but also previously recovered ones. From a statistical point of view, Sequential recovery can be viewed as transforming the original MAP estimation problem that requires a block wise conditional probabilistic model into a series of easier MAP estimation problems that only require a pixel wise conditional probabilistic model. Such transformation substantially alleviates the complexity of statistical modeling (i.e., from block wise to pixel wise) and offers a ground for the development of new error-concealment techniques. The principal advantage of sequential recovery over parallel recovery is the improved capability of modeling important image features such as edges. Previous parallel approaches attempt to explicitly resolve the uncertainty of edge orientation and edge quantity based on geometric analysis.

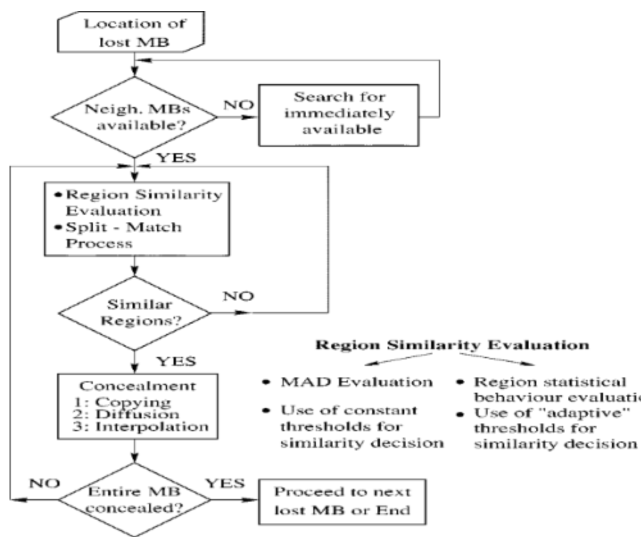

Fig. 1. Flowchart of the FEC algorithm.

II. PROBLEM FORMULATION

The error-concealment problem deals with the estimation of some corrupted blocks from their neighboring blocks that Fig. 1.1 (a) Isolated block loss. (b) Consecutive block loss (horizontal). (c) Consecutive block loss (diagonal). have been successfully received at the decoder. According

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to the availability of the neighboring blocks, we can classify the block-loss situations into two types: *isolated* block loss and *consecutive* block loss. If the eight surrounding blocks of the missing block are all successfully received, we treat it as isolated block loss; otherwise, it is consecutive block loss.

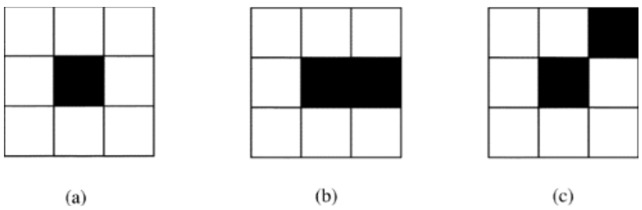
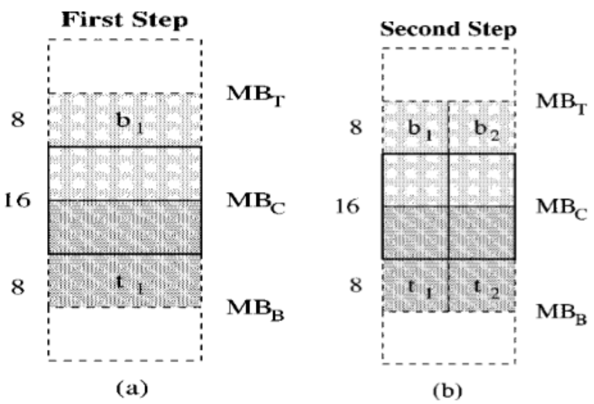
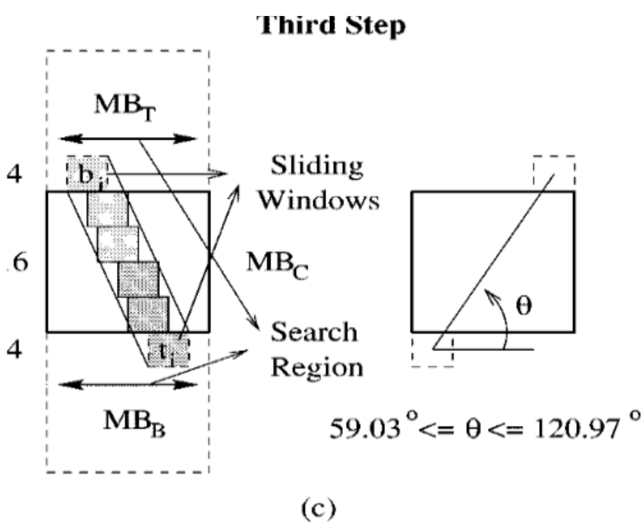


Fig. 1.1 shows the examples in different block-loss situations.





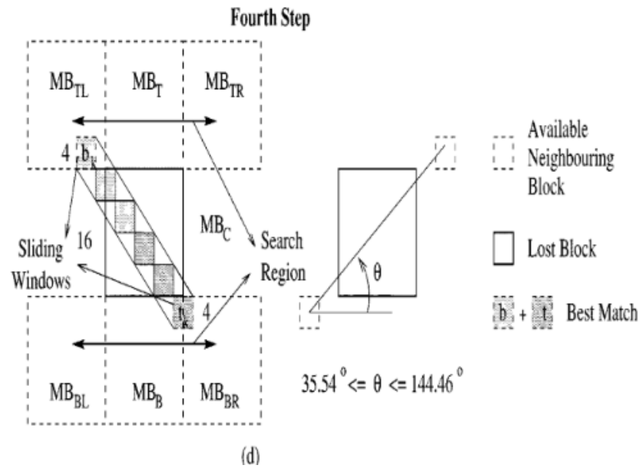


Fig. 2. Schematic presentation of the split-match algorithm.MB_T; MB_B ; MB_{TL} ; MB_{TR} ; MB_{BL} ; MB_{BR} are adjacent to the lost one,MB_C ; MB's.

A brief description of the four steps of the algorithm follows.

• *Step 1:* ***Initialization****—Maximum Block Size* Initialization is performed by attempting to match the largest vertically neighboring blocks b_1 and t_1 of size 16 X 8 pixels, as shown in Fig. 2(a). If these regions are considered similar, entire MB concealment follows by copying, as shown later on. Otherwise, the algorithm proceeds to the second step.

• *Step 2:* ***First Splitting****—Vertical Directions Only* The initial blocks of the 1st step are split into t wo*n* smaller ones, b_1 , b_2 and t_1 , t_2 respectively, of size 8 X 8 (horizontal splitting) and matching is performed in the vertical direction only for each pair separately, i.e. b1 with and with [see Fig. 2(b)]. Thus, concealment of smaller flat or textured regions (or regions at the borders of high spatial activity areas) is directly performed.

• *Step 3:* ***Second Splitting****—Definition of Initial Search Region—Smaller Set of Directions*
The blocks of Step 2 are further split to the smallest allowable ones of size 4 X 4, denoted by bi and ti Now though, an initial horizontal search region is additionally defined as shown in Fig. 2(c). The smallest blocks to be matched bi with ti slide inside the search regions and all their combinations are considered for "best match" determination based on similarity decisions introduced previously. This step is performed iteratively until the next best combination of blocks mismatches or entire MB concealment is achieved. The concept of sliding windows ensures edge or line reconstruction at any direction.

• *Step 4:* ***No Splitting****—Enlargement of Search Region—*

Larger Set of Directions

The search regions of Step 3 are further enlarged, as shown in Fig. 2(d), to allow the possibility of a larger set of reconstructed directions extending to neighboring left and right top or bottom MB's. The block size remains the same and matching is performed between b_k and t_k shown in Fig. 2(d). This step is performed iteratively until entire MB concealment. It is noted that reconstruction of horizontal or almost horizontal lines or edges is impossible when using information from only top and bottom available MB's, especially in cases where several consecutive slices are lost.

III. SIMULATION RESULTS

To compare our sequential error-concealment techniques with previous parallel techniques, we use the traditional PSNR as the objective measure in our experiments. PSNR is defined by

$$PSNR = 10 \log 10 [255^2 / MSE] \quad (1)$$

where MSE is the normalized mean-square difference between the original blocks and the reconstructed blocks

$$MSE = \frac{1}{|N_{cb}|} \sum_{b \in N_{cb}} \left\{ \frac{1}{B^2} \sum_{i=1}^{B} \sum_{j=1}^{B} (X_{i,j}^b - \dot{X}_{i,j}^b)^2 \right\} \quad (2)$$

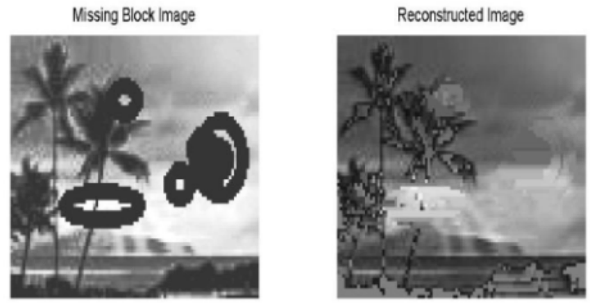
Where the collection of all is corrupted blocks and is the reconstructed image. It should be noted that the PSNR value given by (1) and (2) is usually smaller than the PSNR value computed for the entire image that is commonly used in image coding. The difference between the two PSNR values is a constant which is dependent on the block-loss ratio.

1. 8X 8 Block

Previous works [13], [14] have considered the situation of the 8 X 8 block. Three different block-loss situations are investigated

1) Isolated block loss (%);
2) Consecutive block loss (%);
3) Mixture of isolated and consecutive block loss (%).

Table II includes the PSNR comparison results between [13] , [14] and ours for the Lena image in various block-loss situations. The PSNR performance improvement over [14] ranges from 0.6 to 0.8 dB. It appears that the improvement on the visual quality is more impressive than the PSNR values. Shows the comparison of the reconstructed Lena images given by [13], [14], and our new technique in the situation of 25% isolated block loss. It can be observed that the new technique has achieved noticeable improvements in the area of complex texture structures. Local structures such as streaks and corners are recovered with better fidelity. For better subjective evaluation, the enlarged portions around the hairs. Several portions where new technique outperforms previous ones are highlighted in the original image.



Nature.bmp

Fig 1 PSNR: 11.61 dB, Total Time Required: 2.79 s

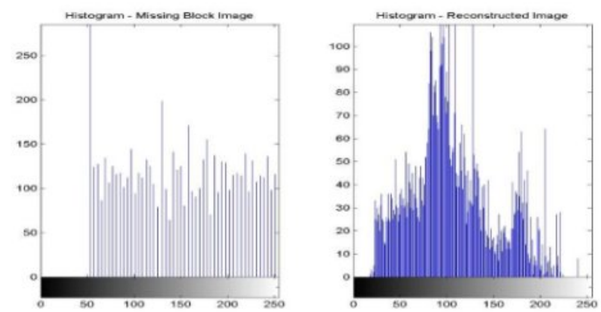
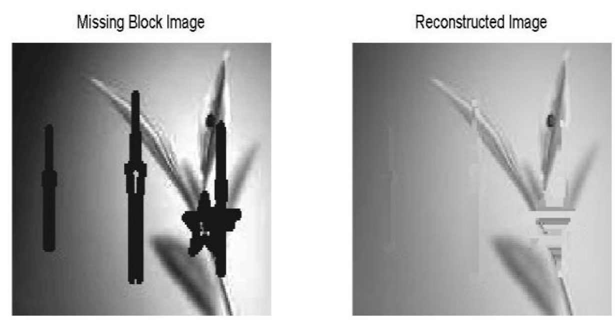


Fig 2 Output Histogram



Tree.bmp

Fig 3 PSNR: 12.80 dB, Total Time Required: 1.65 s

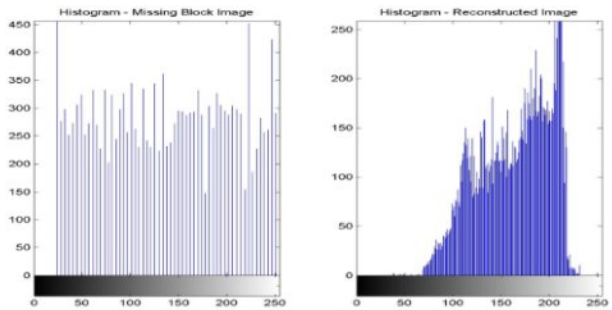


Fig 4 Output Histogram

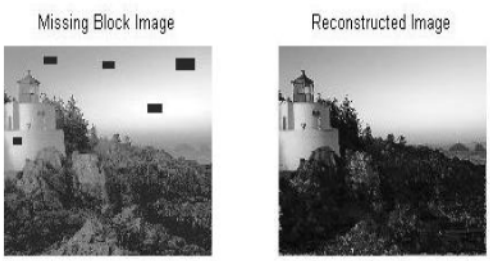


Fig 5. PSNR: 17.95 dB, Total Time Required: 314.79 s: Lighthouse.bmp

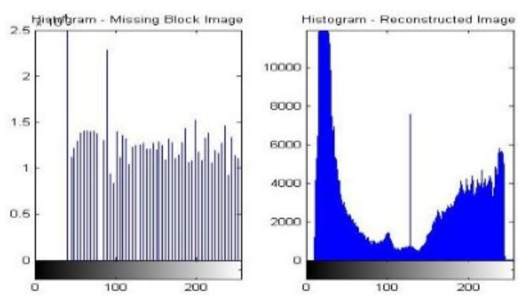


Fig 6. Output Histogram

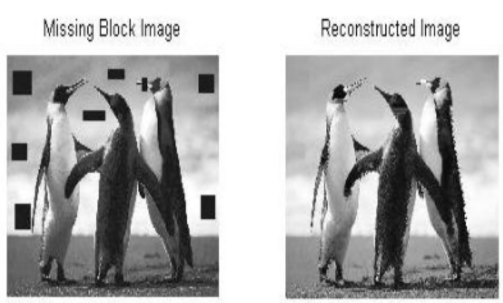


Fig 7. DIB Format – Microsoft Windows Device Independent Bitmap PSNR: 7.25 dB, Total Time Required: 130.39 s: Penguins .dib

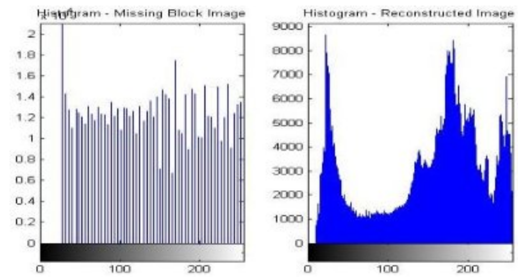


Fig 8. Output of dib format histogram

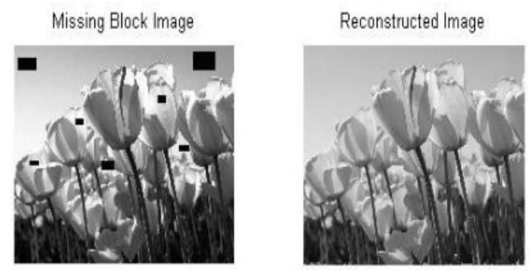


Fig 9. Flowers.dib

PSNR: 9.27 dB, Total Time Required: 20.86 s

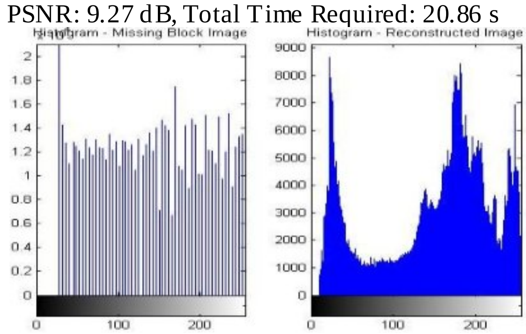


Fig 10. Output Histogram

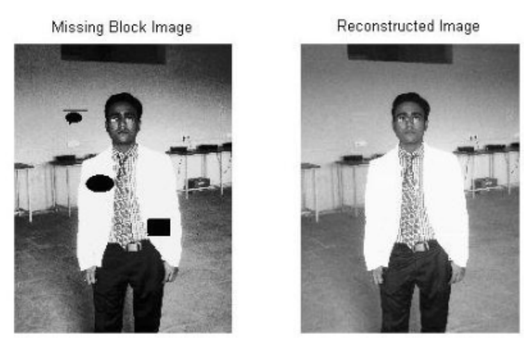


Fig 11. V2.dib

PSNR: 18.65 dB, Total Time Required: 451.84 s: v2.eps

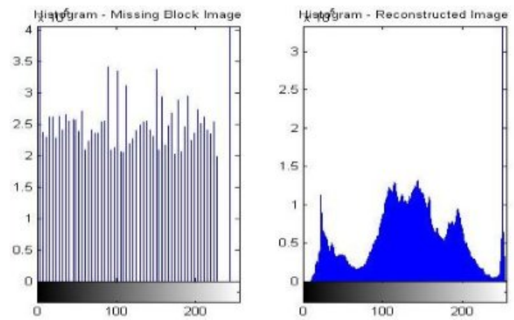


Fig 12. Output Histogram

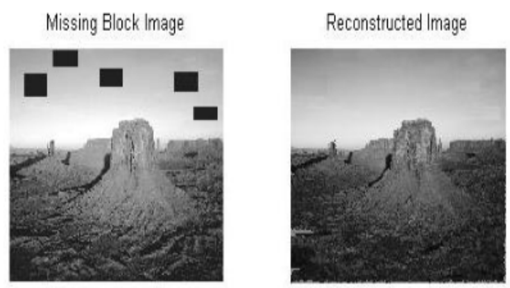


Fig 13. PSNR: 15.75 dB, Total Time Required: 146.38 s: Desert.dib

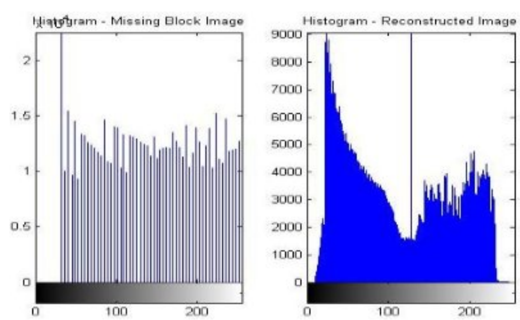


Fig 14. Output Histogram

CONCLUSION

In this paper, we have advanced the state of the art in BMP and DIB data embedding on several fronts. Embedding is lossless in the sense that once the data is removed, the image can be restored to its original state with no changes. The stream, despite carrying a payload, remains syntax-compliant and, hence, viewable by standard viewers. Notably, marked images can be made mathematically and, thus, visually identical to the original image.

REFERENCES

[1] W. Pennebaker and J. Mitchell, *JPEG Still Image Data Compression Standard*. Norwell, MA: Kluwer, 1992.

[2] J. Mitchell,W. Pennebaker, and C. E. Fogg, *MPEG Video: Compression Standard*. Norwell, MA: Kluwer, 1996.

[3] Y. Wang and Q. Zhu, "Signal loss recovery in DCT-based image and video codecs," in *Proc. SPIE Conf. Visual Communication and mage Processing*, vol. 1605, Nov. 1991, pp. 667–678.

[4] H. Sun and W. Kwok, "Concealment of damaged block transform coded images using projection onto convex set," *IEEE Trans. Image Processing*, vol. 4, pp. 470–477, Apr. 1995.

[5] P. Salama, N. B. Shroff, E. J. Coyle, and E. J. Delp, "Error concealment techniques for encoded video streams," in *Proc. Int. Conf. Image Processing*, vol. I, Oct. 1995, pp. 9–12.

[6] J.W. Park, J.W. Kim, and S. U. Lee, "DCT coefficients recovery-based error concealment technique and its application to the MPEG-2 bit stream error," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 7, pp. 845–854, Dec. 1997.

[7] J. W. Park and S. U. Lee, "Recovery of corrupted image data based on the NURBS interpolation," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 9, pp. 1003–1008, Oct. 1999.

[8] X. Lee, Y. Zhang, and A. Leon-Garcia, "Information loss recovery for block-based image coding techniques—A fuzzy logic approach," *IEEE Trans. Image Processing*, vol. 4, pp. 259–273, Mar. 1995.

[9] J.-W. Suh and Y.-S. Ho, "Error concealment based on directional interpolation," *IEEE Trans. Consumer Electron.*, vol. 43, pp. 295–302, Aug.
1997.

[10] Z. Wang, Y. Yu, and D. Zhang, "Best neighborhood matching: An information loss restoration technique for block-based image coding systems," *IEEE Trans. Image Processing*, vol. 7, pp. 1056–1061, Jul. 1998.

[11] W.-M. Lam and A. Reibman, "An error concealment algorithm for images subject to channel errors," *IEEE Trans. Image Processing*, vol. 4, pp. 533–542, May 1995.

[12] W. Zhu, Y. Wang, and Q. Zhu, "Second-order derivative-based smoothness measure for error concealment in DCT-based codecs," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 8, pp. 713–718, Oct. 1998.

[13] K. Jung, J. Chang, and C. Lee, "Error concealment technique using projection data for block-based image coding," in *Proc. SPIE Conf. Visual Communication and Image Processing*, vol. 2308, 1994, pp. 1466–1476.

[14] W. Zeng and B. Liu, "Geometric-structure-based directional filtering for error concealment in image/video transmission," in *Proc. SPIE Conf. Wireless Data Transmission, Photonics East*, vol. 2601, Oct. 1995, pp. 145–156.