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Multiple-Scan Lossless Predictive Huffman Coding

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Abstract — *With the recent spurt in the growth of multimedia technology, the demand for digital image compression has increased dramatically for image storage and transmission. The basic goal of image compression is to represent an image with minimum number of bits on one side and maintain an acceptable image quality for the application under consideration, on the other. The aim of all image compression algorithms is to reduce the amount of data as much as possible by removing statistical redundancy and visual insignificance. Compression can be lossless or lossy. The lossless methods include the Huffman coding, Run-length coding, Linear Predictive method, Arithmetic coding and the Lempel-Ziv coding, this paper proposes the hybrid Multiple-scan Predictive Huffman coding method for lossless compression. The technique gives better results*

Keywords- *Gaussian noise, Wavelets, Bayes Thresholding Image compression, Lossless compression, Lossy compression, Huffman coding, Linear Predictive coding.*

I. INTRODUCTION

Image data compression [1]-[11] is important because image files generally contain a considerable amount of redundant and irrelevant information. Data compression techniques exploit inherent redundancy and irrelevancy for transforming a data file to a smaller file, from which the original file can later be reconstructed exactly or approximately. The ratio of the two file sizes, known as the compression ratio, specifies the degree of compaction.

Some data compression algorithms are lossless, while others are not. A lossless algorithm eliminates only redundant information, permitting exact recovery of the image upon decompression of the file. The application for Lossless compression includes archives, medical imaging, technical drawings and clip art. Methods for lossless image compression include:

a) Run-length encoding [12]
b) Predictive Coding [13]-[14]
c) Entropy encoding such as Huffman [15] and Arithmetic coding [16]
d) Adaptive dictionary algorithms such as LZW [17]

Huffman coding is an entropy encoding algorithm used for lossless data compression. The Huffman coding is based on the use of a variable-length code table for encoding a source symbol. The derivation of the variable-length code table is based on the estimated probability of occurrence of each possible value of the source symbol. It was developed by David A. Huffman [15]. Huffman coding of images is based on the frequency of occurrence of a particular intensity pixel in images. It is based on the concept of using a lower number of bits to encode the intensities that occur more repeatedly. The Code Book stores the codes which may be constructed for each image. The code book along with the encoded data must be transmitted to enable decoding for every case. During coding the gray levels of an image, the Huffman codes contain the smallest possible number of code symbols per source symbols with the condition of coding the source symbol in serial manner.

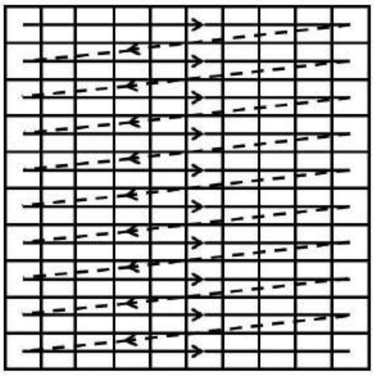
Predictive coding techniques [13] [14] also exploit interpixel redundancy. The basic idea, in this case, is to encode only the new information in each pixel, which is usually defined as the difference between the actual and the predicted value of that pixel. The main part is the predictor, whose role is to create a predicted value for each pixel from the input image on the basis of the previous pixel values. The output of the predictor output is rounded off to the nearest integer and compared with the actual pixel value. The predication error which is the difference between the two is then encoded by an encoder. As the prediction errors are likely to be smaller as compared to the original pixel values, the encoder is likely to generate smaller codeword's. The literature shows the availability of various local, global, and adaptive prediction algorithms. It has been found that in majority of the cases, the predicted pixel value is a linear combination of the former pixels. Predictive coding can be either lossless or lossy.

The rest of the paper is arranged as follows. The proposed technique is introduced in section II. The experimental results are shown in section III while the conclusion is presented in section IV.

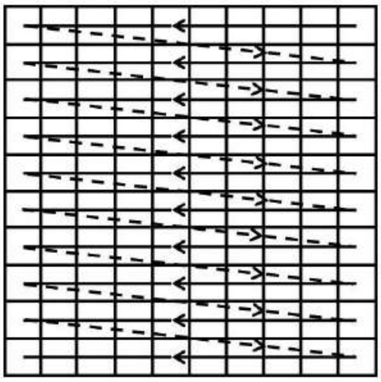
II. METHODOLOGY

Predictive coding is based on eliminating the redundancy of closely spaced pixels by extracting and coding only the new information in each pixel. The new information of a pixel is defined as the difference between an actual and predicted value of the pixel.

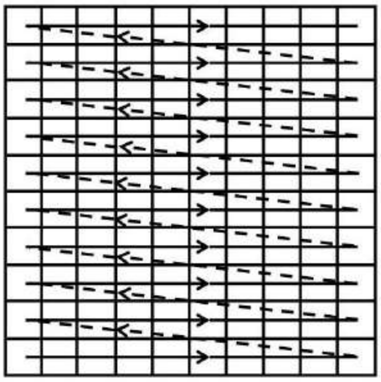
The proposed scheme of multiple scanning aims to identify the orientation that would give the maximum compression. Four scans in the directions top left, top right, bottom left and bottom right are used for this purpose, as shown in Fig. 1. The block diagram of the lossless predictive coding is shown in Fig. 2. The system consists of an encoder and a decoder, each containing an identical predictor. As successive pixels of the input image X (i, j) are introduced to the encoder, the predictor generates the anticipated value of each sample based on a specified number of past samples. The output of the predictor is then rounded off to the nearest integer, denoted Y (i, j), and used to form the difference or prediction error.



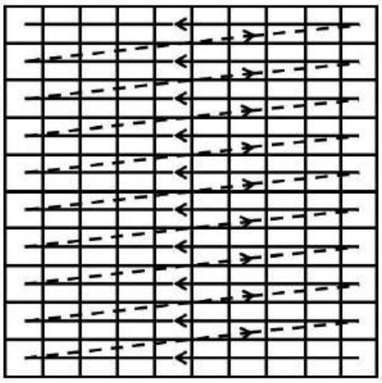
(a)



(b)



(c)



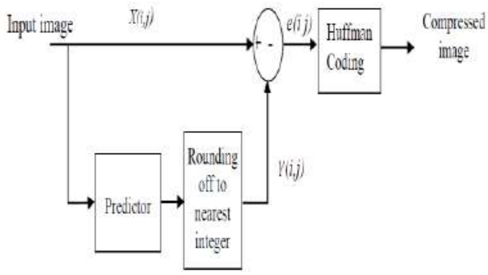
(d)

Figure 1 Multiple Scanning Diagram for Four Directions (a) Top Left (TL) (b) Top Right (TR) (c) Bottom Left (BL) (d) Bottom Right (BR)

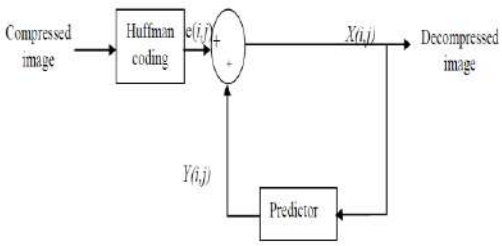
$$e(i, j) = X(i, j) - Y(i, j) \quad (1)$$

this is encoded using Huffman code to generate the next element of the compressed data stream. The decoder in Fig.2 (b) reconstructs e (n) from the received Huffman code words and performs the inverse operation given by eq. (2) to decompress or recreate the original input sequence.

$$X(i, j) = e(i, j) + Y(i, j) \quad (2)$$



(a)



(b)

Figure 2 Lossless Predictive Model (a) Encoder (b) Decoder

The process of lossless compression using multiple scan predictive Huffman coding is as follows:

Stage 1: Application of lossless predictive coding to a test image.

Stage 2: Application of Huffman coding to the output of the above step and determination of the compression ratio of the resulting matrix.

Stage 3: Repetition of the above two steps for the other three orientations viz. top right, bottom left and bottom right as shown in Fig. 1

Stage 4: Comparison of the compression ratios of the image obtained by the four orientations to identify the best compression ratio.

TABLE 1 Comparison of Compression Results for Six Benchmark Images using MLPHC

Compression Technique / Benchmark Image ↓	Huffman Coding	LPC method	MLPHC
Lena	1.0698	1.6646	1.8866
Peppers	1.0492	1.5055	1.5420
Barbara	1.0535	1.2299	1.3066
Lighthouse	1.0676	1.3522	1.3942
Mandrill	1.0469	1.1293	1.1300
Grass	1.0368	1.0829	1.1271

III. EXPERIMENTAL RESULTS

The proposed Multiple-scan Lossless Predictive Huffman coding (MLPHC) technique has been applied

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to the six benchmark images and the compression ratios have been tabulated as shown in the Table 1. It can be seen from the compression ratios depicted in Table 1 that the Multiple-scan Lossless Predictive–Huffman Coding performs significantly better than the Huffman or the Lossless predictive coding method. It has been found that the best orientation in most cases is not the orientation of the original image. The best orientation in terms of compression ratio has been found to be dependent upon the type of image.

IV. CONCLUSION

A novel lossless technique i.e. Multiple-scan Lossless Predictive-Huffman Coding has been proposed in this paper. It has been found that the performance of this technique is superior to the Huffman or the lossless predictive coding method. The technique has been applied to various benchmark images viz. Lena, Peppers, Barbara, Lighthouse, Mandrill and Grass.

The future work may focus on reducing the processing time and increasing the compression ratio while maintaining the image fidelity.

REFERENCES

[1] R. C. Gonzalez and R. E. Woods, “Digital Image Processing”, 2nd edition, *Prentice Hall*, 2002.
[2] B. Chanda and D. Majumdar, “Digital Image Processing and Analysis”, *Prentice Hall of India,* 1996.
[3] A. K. Jain, “Fundamentals of Digital Image Processing”, *Prentice Hall of India*, 1989.
[4] K. R. Castleman, “Digital Image Processing”, *Pearson*, 1996.
[5] A. Bovik, “Handbook of Image and Video Processing”, *Academic Press*, 2000.
[6] D. Solomon, “Data Compression –The Complete Reference” 4th edition, *Springer*, 2007.
[7] M. Alwani, and A. K. Tiwari, "A Survey on Lossless Image Compression Methods", IEEE, International Conference on Computer Engineering and Technology, April 2010, Chengdu, China. 735.
[8] X. Wu and N. Memon, "Context-based, adaptive, lossless image coding", IEEE Trans. Commun., Vol. 45, No. 4, pp. 437-444, Apr. 1997.
[9] M. J. Weinberger, G. Seroussi, and G. sapiro, "The LOCO-I lossless image compression algorithm: principles and standardization into JPEG-LS", IEEE Trans. Image Processing, Vol. 9, No.8, pp. 1309-1324, Aug, 2000.
[10] M. J. Weinberger, G. Seroussi, and G. Sapiro, "A Low Complexity, Context-Based, Lossless Image Compression Algorithm", Proc. of the Data Compression Conference, Snowbird, Utah, March, 1996.
[11] B. Meyer and P. Tischer, "TMW- a New Method for Lossless Image Compression", Proc. of Picture Coding Symposium (PCS), Berlin, Germany, Oct, 1997.
[12] S. W. Golomb, "Run-length encodings", IEEE Transactions on Information Theory, Vol. IT-12, pp. 399401, July 1966.
[13] G. Motta, J. A. Storer, and B. Carpentieri, "Lossless image coding via adaptive linear prediction and classification", Proceedings of the IEEE, Vol. 88, No.11, pp. 1790-1796, 2000.
[14] Aleksej Avramovic and Salvica Savic, "Lossless Predictive Compression of Medical Images", Serbian Journal of Electrical Engineering, Vol. 8, no.1, pp. 27-36, Feb. 2011.
[15] D. A. Huffman, "A method for the construction of minimum redundancy codes", Proceedings of the IRE, Vol. 40, no. 9, pp. 10981101, September 1952.
[16] I. H. Witten, R. Neal, and J. M. Cleary, "Arithmetic Coding for Data Compression", Communications of the ACM, Vol. 30, no. 6, pp. 520540, June 1987.
[17] Welch, T.A. “A Technique for High-Performance Data Compression.” IEEE Computer, vol. 17, no. 6 (June 1984), pp. 8-19.

AUTHOR’S PROFILE

Dr. Sandip Mehta received Bachelor of Engineering degree in Electrical Engineering and Master of Engineering (Control Systems) both from M.B.M. Engineering College, Jodhpur, in 1994 and 2002 respectively. He received his PhD Degree from M.B.M. Engineering College, Jodhpur, in 2014. Currently he is Professor in Department of Electrical and Electronics Engineering, at JIET Group of Institutions. He has over 18 years of experience in academics, research and industry. He is registered PhD supervisor in RTU, Kota. His areas of interest include Electromagnetic Field Theory, Electric and Electronics Engineering Materials, Electrical Machines-Theory and Design, Power Electronics, Soft Computing and Image Processing.