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Image Compression Using BPD with De Based Multi- Level Thresholding

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Abstract: *Image compression plays a vital role in efficient, faster transmission and storage. These techniques are mainly of two types; spatial domain and transform domain. In this paper a new spatial domain approach with Binary plane difference (BPD) with multi thresholding is proposed. Here for the evaluation of thresholding the gray levels are divided into certain probabilistic groups for which Shannon entropy is used to measure its randomness. This entropy is maximized using differential evolution (DE) approach to reduce the computational time. This approach is further compared against the Binary plane technique and DE based multilevel thresholding method. Experimental results shows that the proposed approach is out standing with a compression ratio of 0.93 on average and 34.48 of PSNR at different levels and images.*

Keywords: *Image compression, Binary plane difference, Entropy, Differential evolution.*

1. INTRODUCTION

For the efficient display of the spatial components (Images) different images are attained and stored digitally, which are usually acquired from special equipments. These acquired images are quite large in resolution and data size and in such situation; compression reduces the cost of storage and enhances transmission speed.

In the recent period, image compression plays a significant role in effective images related operations. However, it is very crucial to make a note that compression of images is of minor loss of information from the original content, regardless of which may cause serious consequences [1]. Conventionally, the image coding techniques are classified as lossless or lossy where the small image information is of significant importance in advance imagining field.

Much of research and standard methods were proposed earlier for image compression. Several advanced image compression technique have been developed related to the growing demands for image storage and transmission. The JPEG 2000 [3] [4] combined embedded block coding with the optimized truncation (EBCOT) technique with the lifting integer wavelet transform to perform several advance features and capable to provide high performance lossless compression as compared to JPEG [2] low bit rate technique.

The Wu and Memon [5] [6], proposed the context based adaptive lossless image codec (CALIC) approach using enclosing 360 modeling contexts to attain the distribution of the encoded symbols and the prediction scheme. Moreover, William A. Pearlman and Said Amir [7], proposed Set partitioning in hierarchical trees (SPIHT) technique which utilizes the inherent similarities around the sub-bands in a wavelet decomposition of the image. The S.Mahaboob Basha, Dr. B. Sathyanarayana and Dr. T. Bhaskara Reddy [8] proposed a binary plane technique which is used to take advantage of repeated values in the consecutive pixels positions.

In [9] Subhash et.al proposed BDH based approach which presents the effect of using the Difference coding [10] in between the Binary Plane technique and Huffman coding technique.

In [11] S.paul et.al presents, differential Evolution (DE) optimization approach for multi level thresholding leading to a low complexity and fast processing approach .

This paper also concentrates on lossy image compression technique using Binary plane approach with differential evolution based thresholding. The rest of the paper is organized as , section 1 describes the need and necessity of the research , basic literature and related work done by earlier researchers. Section 2 briefly presents the related content which is used in the proposed approach. Section 3 clearly explains about the proposed approach and the steps that were employed in this paper ending up with the experimental results in section 4 presenting with different outcomes of the proposed approach.

2. Related Work

2.1. Binary Plane Technique (Lossy Approach)

The binary plane technique is used in the first stage of compression where the compressed file which is usually maintained in two parts , the first part is bit plane which holds the bits '0' for each pixel similar to the previous pixel and bit ' 1' for each pixel different from the previous pixel . While, the second part is the data table which holds only the essential pixel values that is for the set of consecutive repeated values and only one value is stored in the data table. In the technique, the current values are stored in the table if it is not similar as previous value and not stored if it is similar to the previous values and later the bit plane and data table are merged into one file. However, the main aim of this technique is acquiring benefits of the similar value in the consecutive pixels and instead of storing all of them. Moreover, the main advantage of binary plane technique is that it helps to maintain the gray scale value while compression which provides better quality image as compared to other compression techniques.

The Method is based on Spatial Domain of the Image and is Suitable for Natural and Synthetic Image Compression. The main aim of the technique is to use the repeated values in consecutive pixels positions. For a set of repeated consecutive values only one value is retained. In the Binary Plane technique two codes are used to built the bit plane. The codes are has given below

Code 1(one) is used to indicate the current pixel is different from the previous pixel. In this case the current pixel is moved to the data table.

Code 0 (Zero) is used to indicate the current pixel is exactly same as the previous pixel. This eliminates the storage of the current pixel.

For e.g If the Image file contains the following pixels

128 80 80 80 300 90 90 180 180 180 180 20 20 223 99 99 99 then the bit plane file contains

1100110100011100 and data file is as below

128 300 90 180 20 223 99

In the Lossy binary plane technique a scalar quantization is done for the data table using equation (1)

$$\left(\mathrm{PP}-\frac{\mathrm{TV}}{2}\right) \geq \mathrm{CP} \leq \left(\mathrm{PP}+\frac{\mathrm{TV}}{2}-1\right) \quad (1)$$

Where PP-Previous pixel, CP-current Pixel, TV-Threshold value then the range of data table will be modified as shown in the figure 1

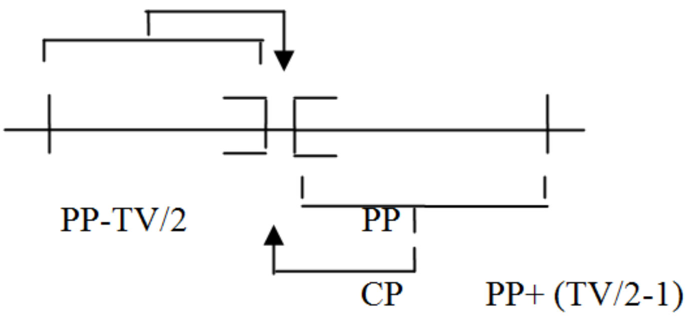

Figure1. *Modification of the data table with threshold value*

For eg: let us consider a numerical example, if the image file contains the following pixels

128 300 90 180 20 223 99 TV=4 ϵ [-2, +1]

Table1. *Modification of Data Table*

P	PP	RANGE	BP	DT
128	0	(-2,1)	1	128
75	128	126-129	1	75
77	75	73-78	0	--
79	75	73-78	1	79
80	79	77-81	0	--
115	79	77-81	1	115
119	115	113-116	1	119
125	119	117-120	1	125
180	125	123-126	1	180
188	180	178-181	1	188

The Data Table is 128 75 79 115 119 125 180 188 and the Binary Plane is 1101011111

2.2. Differential Evolution Based Thresholding

Differential Evolution (DE) has recently emerged as a simple yet very competitive evolutionary optimizer. It is an iterative population-based optimizer like other evolutionary algorithms. In DE the i^{th} individual of the population at generation time step t is a D- dimensional vector, containing a set of D optimization parameters

$$\vec{Z_l}(t) = [Z_{i,1}(t), Z_{i,2}(t), \ldots \ldots, Z_{i,D}(t)] \quad (2)$$

The population is randomly initiated within the search space. In each generation to change the population members $\vec{Z_l}(t)$ (say), first $a\ donor$ vector $\vec{Y_l}(t)$is created through mutation. In one of the earliest variants of DE, named DE/rand/1 scheme, to create $\vec{Y_l}(t)$ for each i^{th} member, three other parameter vectors (say the $r_1, r_2, and\ r_3^{th}$ vectors are such that $r_1, r_2, r_3 \in [1, NP]$, and $r_1 \neq r_2 \neq r_3$) are chosen at random from the current population. The donor vector $\vec{Y_l}(t)$is then obtained as follows

$$Y_{i,j}(t) = Z_{r1,j}(t) + F.\left(Z_{r2,j}(t) - Z_{r3,j}(t)\right) \quad (3)$$

Where F is a scalar quantity, called scaling factor, in order to increase the potential diversity of the donor vector, a binomial crossover is performed to create a trial vector, as follows,

$$R_{i,j}(t) = Y_{i,j}(t)\ , if\ rand_j\ (0,1) \leq Cr, or\ j = rn(i) = Z_{i,j}(t)\ \ otherwise \quad (4)$$

Where $j = 1, 2 \ldots D$ and $rand_j\ (0,1) \in [0,1]$ is the jth evaluation of a uniform random number generator and $rn(i) = 1, 2, \ldots \ldots, D$ is a randomly chosen index to ensures that $\vec{R_l}(t)$gets at least one component $\vec{Z_l}(t)$. Cr is the crossover rate. Finally 'selection' of the new vector is performed as follows,

$$\vec{Z_l}(t+1) = \left.\begin{matrix} \vec{R_l}(t)\ , if\ f\left(\vec{R_l}(t)\right) \leq f\left(\vec{Z_l}(t)\right) \\ \vec{Z_l}(t), if\ f\left(\vec{R_l}(t)\right) > f\left(\vec{Z_l}(t)\right) \end{matrix}\right\} \quad (5)$$

Where f(.) is the function to be minimized. The above steps are repeated until the stopping criterion is met. In our proposed algorithm, the stopping criterion is number of iterations.

3. PROPOSED APPROACH

The proposed approach is a combination of both DE based thresholding and BPT algorithm. By combining these algorithms the limitation of attaining multiple thresholding will be reduced by achieving a higher compression ratio. This method also provides a higher quality of the reconstructed image which makes it in sense to be called a quasi lossy compression approach. The following are the steps that were employed in the proposed approach

- Read a Gray level image with high data size
- Calculate the histogram probabilities

- Set number of iterations and levels for minimizing of probabilities
- Apply differential evolution approach to get a optimized threshold values
- Consider the first threshold value and make it in the limits of [-|Th/2| |Th/2|] where | | represents the floor operation.
- Apply BPD algorithm with this optimized threshold value as mentioned in section 2.
- Evaluate the performance of algorithm with compression ratio, Peak signal to noise ratio (PSNR) metrics

4. EXPERIMENTAL RESULTS

For the implementation of the proposed approach Raw uncoded images were considered whose resolution is 200x200. The algorithm is tested on Matlab 2013 version with Intel Dual core processor with 4GB RAM.

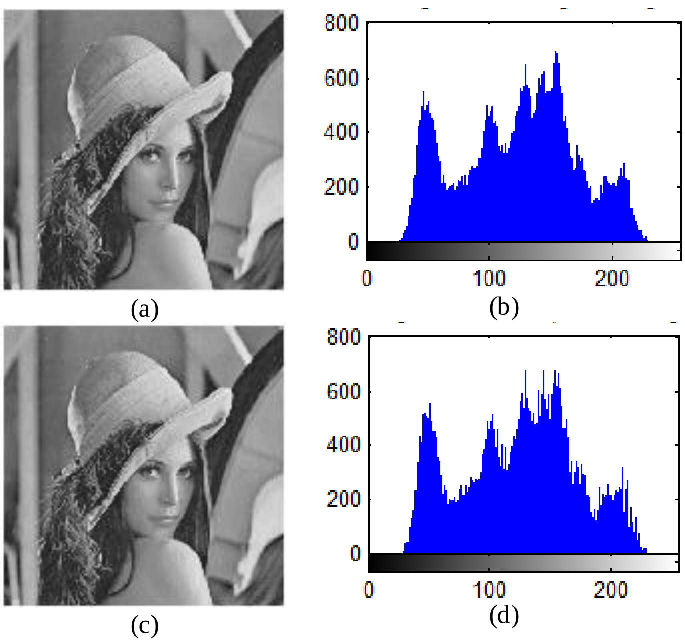

Figure2. *(a) Original Image (b) its Histogram (c) Compressed Image at Level =128 and Iterations=2 (d) its Histogram*

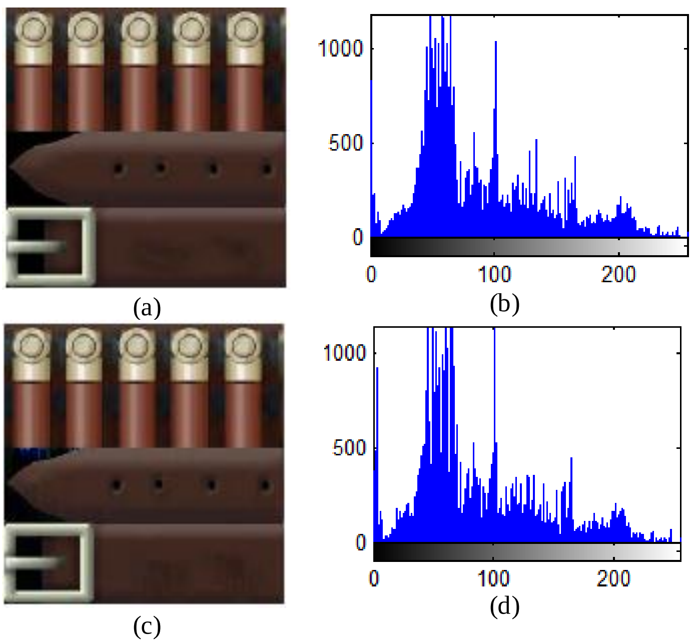

Figure3: *(a) Original Color Image (b) its Histogram (R-Component) (c) Compressed Image at Level =128 and Iterations=2 (d) its Histogram (R-Component)*

Table2. *Performance Analysis of the proposed approach at different Levels*

Image (Lena)	PSNR	Compression Ratio
Level=2	27.88	0.964
Level=4	28.23	0.929
Level=8	28.53	0.921
Level=16	29.15	0.895
Level=32	30.07	0.894
Level=64	38.28	0.934
Level=128	57.73	1.004

Table3. *PSNR comparison of the proposed approach with earlier approaches at Level=32*

Image	BPT	DE	Proposed
Lena	29.73	28.73	30.07
Barbara	32.02	28.20	34.89
Zelda	31.01	28.98	31.52
Cameraman	34.20	31.00	34.86
Baboon	33.65	30.44	41.06
Average	32.12	29.47	34.48

5. CONCLUSION

A combination of differential evolution and Binary plane technique is proposed in this paper. It is found from the experimental results that the proposed approach is better when compared with individual methods. It is found that this approach is providing 2-3dB improvement in PSNR and also provides a better quality at higher compression ratios. This approach can be further extended with performing this approach in transform domain.

REFERENCES

[1] D.A. Karras, S.A. Karkanis, and D. E. Maroulis, "Efficient Image Compression of Medical Images Using the Wavelet Transform and Fuzzy c-means Clustering on Regions of Interest," IEEE Trans. Med. Imaging, vol. 2, no. 1, pp. 3-45, 2009.

[2] S. Gupta and R.Bhatia, "Comparative Analysis of Image Compression Techniques: A Case Study on Medical Images," in Advances in Recent Technologies in Communication and Computing. ARTCom '09. International Conference on, 2009, pp. 5-34.

[3] Christopoulos C, Skodras A, and Ebrahimi T., "JPEG2000 still image coding system: an overview ", IEEE Trans Consumer Electron , vol. 46, no. 4, pp. 1103–27, 2000.

[4] Dillen G, Georis B, Legat J, and Cantineau O., "Combined line-based architecture for the 5-3 and 9-7 wavelet transform of JPEG2000. ," IEEE Trans Circuits Syst Video Technology, vol. 13, no. 9, pp. 944–50, 2003.

[5] Wu X., "Lossless compression of continuous-tone images via context selection, quantization, and modeling. ," IEEE Trans Image Process, vol. 6, no. 5, pp. 656–64., 1997.

[6] Wu X and Memon N., "Context-based, adaptive, lossless image coding.," IEEE Trans Commun , vol. 45, no. 4, pp. 437–44, 1997.

[7] Amir Said and William A. Pearlman, "A new fast and efficient image codec based on set partitioning in hierarchical trees," IEEE Transactions on Circuits and Systems for Video Technology , vol. 6, no. 3, pp. 243–250., 1996.

[8] S.Mahaboob Basha and Dr. B. Sathyanarayana, "Image Compression Using Binary Plane Technique," IEEE, vol. 1, no. 1, pp. 4-65, 1996

[9] N. Subhash Chandra et al., "Loss less compression of images using binary plane, difference and huffman coding (BDH technique) ," Journal of Theoretical and Applied Information Technology, vol. 3, no. 1, pp. 3-56, 2008.

[10] Wei Biao Wu, Chinya V. Ravishnakar., “The performance of difference coding for sets and relational tables” Journal of ACM., vol 50, Issue 5(Sep 2003), pp 665-693

[11] S. Paul and B. Bandyopadhyay, "A novel approach for image compression based on multi-level image thresholding using Shannon Entropy and Differential Evolution," Students' Technology Symposium (TechSym), 2014 IEEE, Kharagpur, 2014, pp. 56-61.