IOSR Journal of Engineering (IOSRJEN)
e-ISSN: 2250-3021, **p**-ISSN: 2278-8719
Vol. 3, Issue 11 (November. 2013), ||V5|| PP 14-18

A Post Processing Technique for Reducing Blocked Artifacts in JPEG Image Compression

Mukesh Dalal, Vikram Singh
(Department of Computer Science, CDLU, Sirsa,

Abstract: **-** Compression of digital images has been a topic of research for many years. The main role of compression is to reduce memory requirements for transmission and bandwidth requirements for storage of all forms of data. This paper aims to report a post processing technique to reduce the blocking artifacts in JPEG compressed images up to a very extent keeping in mind that less computation efforts would be made. The proposed approach is hybrid model of both spatial domain and frequency domain in which post processing is performed in two phases. In first phase, pre-filtering is implemented in spatial domain while second phase, selected DCT coefficients are modified.

Keywords: - *Anti-aliasing filter, The APDCT (All Phase Discrete Cosine Transform), Blocking artifacts, JPEG image Compression, PSNR.*

I. INTRODUCTION

Data compression is the conversion of a stream of analog or very high rate discrete data into a stream of relatively low rate data for communication over a digital communication link or storage in a digital memory. Digital images contain large amount of information that need evolving effective techniques for storing and transmitting the ever increasing volumes of data. Image compression addresses the problem by reducing the amount of data required to represent a digital image. Discrete Cosine Transformation (*DCT*), quantization and entropy encoding are the steps in the compression of the *JPEG* image format. The *DCT* works by separating images into parts of differing frequencies. During quantization, where parts of compression actually occur, the less important frequencies are discarded, hence the use of the term lossy. The remaining most important frequencies are used to retrieve the image in the decompression process. As a result, reconstructed image is an image with distortion [8]. Since the one-dimensionally reordered array generated under the zigzag pattern is qualitatively arranged according to increasing spatial frequency, the JPEG coding procedure is designed to take advantage of the long runs of zeros that normally result from the reordering [6].

Transform-based data compression is by far the most popular choice in both image and video coding applications and it has been a very popular technique for digital image compression. Due to its near-optimal energy compaction property and the availability of fast algorithms and hardware implementations, the block-based discrete cosine transform (*BDCT*) is the dominant one among various transforms. Therefore, the *BDCT* is used in most of current image and video compression standards, such as *JPEG* and *MPEG*. The basic approach is to divide the whole image into fixed size blocks (normally **8x8** or16x16). Then the image data is de-correlated via an orthogonal transform. In JPEG, the Discrete Cosine Transform (*DCT*) is used. After the image data has been transformed into frequency domain, the *DCT* coefficients are quantized and the 2-D data is converted to 1-D using the zigzag structure. [6] The non-zero amplitudes and run-length of zeros is then coded and saved or further transmitted. The *BDCT* based coding can successfully compress images by a factor of around ten, with nearly no perceptible artifacts. Due to the quantization step of the *JPEG* algorithm, at low bit rates, a major problem associated with the *BDCT* manifest visually objectionable artifacts. One of the well-known artifacts in low-bit-rate transform-coded images is the blocking effect, which is noticeable in the form of undesired visible block boundaries.

II. REDUCTION OF BLOCKED ARTIFACTS

In [13] ***Bing Zeng*** provided a solution for the *DCT* transformed blocking artifacts, although before this solution several techniques were made available to minimize the blocking effects. The theory of projection onto convex sets (*POCS)* has been used to derive some iterative algorithms [9, 10], but they require a large number of iterations to reach the convergence. Method using interleaved image block before the encoding were also suggested [11 12], but they are not in conformity with the coding standards.

In B. Zeng's paper, B. Zeng provided a *DCT* transform domain solution to the problem of blocking effect reduction. In B. Zeng paper, Zeng first recognized that visible boundaries between two adjacent blocks in the coded image are primarily oriented along the horizontal and vertical directions. Then they constituted a new data block that includes the original visible boundary in the middle position and model it as a 2D step function contaminated by noise with zero mean and a small variance. By doing DCT on such blocks, they found that there always exist AC components of significant energy in a few fixed positions. Based on this observation, they proposed to zero out some of these AC components and demonstrated that doing so can make blocking artifacts much less visible.

B. Zeng observed all the blocks which suffer the blocking effect either horizontally or vertically and found that each of these blocks and its neighboring block together constitute approximately a horizontal or vertically 2D step function.

Later **Ying Luo** and **Rabab K. Ward [1]** adopted B. Zeng's concept of zero masking and analyzed this idea further and gave more computationally efficient process to bring more smoothness in low-bit and high-bit rate compressed images in less time while preserving the sharp edges and suppressing the blocking effects. However, the method Y. Luo proposed was totally different from that of B. Zeng's [13]. In [13], good results were obtained at very low bit-rates, i.e., for images with high blockiness effects, otherwise artifact will appear. Y. Luo *et al.*'s method is capable of bringing the smoothing in the case when the blockiness is not so strong. Y. Luo *et al.* explored the idea of correlation between the intensity values of the boundary gray scale values of two neighboring blocks in the DCT domain. The continuity of the pixels across the boundary is recovered from the continuity of the pixels values of the two neighboring blocks. Y. Luo and R.K. Ward [1] observed that for the strong texture and edge regions, the nature of the frequencies of the two neighboring blocks differ from each other. Thus this kind of variation introduces artifacts in these non-smooth regions. Therefore Y. Luo and R. K. Ward firstly detected these regions based on the frequency coefficients. If the two 8×8 neighboring blocks of a boundary have similar frequency properties and the 8×8 pixel area around the boundary does not have high frequencies then the latter area is declared to be of smooth nature.

III. THE PROPOSED ALGORITHM

As we know that when image is compressed at low bit rates, the visually defecting blocking artifacts generates. The algorithm and computation parameters given by **Y. Luo** and **R. K. Ward [1]** is quite efficient in terms of minimizing artifacts and maximizing the visible quality of a decompressed image at low bit rate or very low bit rate.

As stated in [1] that this algorithm is a post processing algorithm so we implemented this algorithm to some standard image which were made to decompressed at very low bit rates and it was found that however the visible quality of image was getting richer but the *PSNR* value was slightly decreasing. As the image quality is measured in *PSNR (db)* against corresponding bit rate, so we tried to fill this gap between decompressed image without the algorithm and image recovered after post processing suggested in [1] algorithm.

In order to increase the PSNR value while maintaining or increasing the visibility quality that was obtained after post processing the Y. Luo and R.K. Wards' [1] algorithm we used the APDCT (All Phase Discrete Cosine Transform) [2] anti-aliasing and low pass filter before applying Y. Luo's algorithm. Since this is a spatial low pass filter so it allowed all the low frequency gray scale values restricting high frequency values, in contrast it suppressed all the high frequency pixels values. The pre-filtering caused to pass only the low frequency gray scale values and finally when these gray scale values were inputted to Y. Luo's algorithm then this pre-filtering reduced the computation complexity and more than this we achieved better compression is that the decoded images

The basic idea of all phase filtering [3] was derived from the superimposing digital filter. This idea was proposed by Hou in [4], which was based on the Walsh, Fourier and *IDCT*.

Here take 7×7 filter for example, and lets have the detailed explanation of the APDCT filter.

Let $[z]_{2N-1}$ be the 1-D unit impulse response vector of all phase frequency filtering, and F_N be the *N-D* response vector, the design of 1-D APDCT filter with the length of *2N-1* is composed of (2) and (3).

$$\left[z_{\frac{1}{2}}\right]_N = [\, z(0), z(1), \dots, z(N-1)]^T = KF_N, \tag{1}$$

$$z(n) = z(-n) \tag{2}$$

$$n = 0,1, \dots, N-1. \tag{3}$$

Where the elements of matrix V are

$$K(m,n) = \begin{cases} \dfrac{N-m}{N^2}, \\ m = 0,1, \dots, N-1, n = 0, \\ \dfrac{1}{N^2}\left[(N-m)\cos\dfrac{mn\pi}{n} - \csc\dfrac{n\pi}{N}\sin\dfrac{mn\pi}{N}\right], \\ m = 0,1, .., N-1, \end{cases}$$

$$n = 1,2,\dots,N-1.$$

Similarly, the method applied to design 1-D filter can be used to design 2-D filter. Suppose the unit impulse frequency response matrix of 2-D filter be $[z]_{(2N-1)\times(2N-1)}$, and $F_{N\times N}$ be the ideal low-pass filter matrix of N×N, the design of 2-D APDCT filter with size (2N-1)×(2N-1) is composed of performance values of

$$[z_{1/4}]_{N\times N} = KF_{N\times N}V^T,$$
$$z(m,n) = z(-m,n) = z(m,-n)$$
$$= z(-m,-n), m,$$
$$n = 0,1,\dots,N-1$$

IV. RESULTS AND DISCUSSION

In order to verify our proposed approach we applied our modified algorithm to several standard images of size 512×512. The quality measure values that we got applying three decompression methods on images at different bit rates is shown in Table 1. In Table-1 some notion will be used to designate the different method, here '**B**' will denote to our basic JPEG compression/decompression algorithm, **'L'** will denote to the algorithm proposed in [1] with JPEG compression/decompression, and '**A**' will denote to the algorithm that we have proposed with the idea of implementing the APDCT filter before implementing [1] algorithm in JPEG compression /decompression.

Table 1

Image	Size	Bit Rate	PSNR (db)		
		bpp	B	L	A
Lena	512 × 512	0.639034	35.78721	34.97826	34.24775
		0.410587	33.6988	33.26925	33.35673
		0.319443	32.3304	32.11007	32.55866
		0.269257	31.25481	31.19589	31.82552
		0.235943	30.4082	30.4133	31.12371
		0.213051	29.62699	29.73108	30.4976
		0.195747	28.98775	29.16224	29.94137
		0.182648	28.44898	28.64119	29.46692
Cameraman	512 × 512	0.571552	38.83284	36.25304	35.33551
		0.379787	35.66638	34.34603	34.36283
		0.300735	33.82659	33.06805	33.46834
		0.257023	32.39632	32.01204	32.60517
		0.226219	31.22943	30.9428	31.70709
		0.205257	30.32567	30.27836	31.04602
		0.188751	29.54375	29.55129	30.36234
		0.175797	28.88331	28.99021	29.76818
Mandrill	512 × 512	1.180088	34.16665	30.98416	29.48894
		0.795166	30.98449	29.20819	28.80957
		0.610184	29.13966	27.97505	28.08642
		0.500237	27.81529	27.02789	27.45208
		0.421543	26.78348	26.16129	26.76762
		0.365406	25.96289	25.58685	26.26335
		0.320431	25.27269	24.96995	25.69842
		0.286297	24.68321	24.47418	25.2202
Jet plane	512 × 512	0.665134	36.55907	34.23614	33.19898
		0.432323	33.99064	32.6677	32.43801
		0.335670	32.34289	31.40995	31.65639
		0.281834	31.14013	30.58345	31.05554
		0.246586	30.19021	29.7732	30.42923
		0.223194	29.33056	29.1481	29.77503
		0.204773	28.59363	28.44535	29.13383
		0.189880	28.00089	27.93186	28.64912
Peppers	512 × 512	0.653950	33.91719	33.18783	32.78939
		0.392578	32.61636	32.12728	32.15995
		0.300785	31.68093	31.34932	31.59835
		0.255356	30.84374	30.70691	31.10314
		0.224854	30.12432	30.04433	30.55853
		0.203770	29.48971	29.54848	30.10345
		0.187798	28.84937	28.97532	29.57284
		0.176300	28.36218	28.58437	29.20233

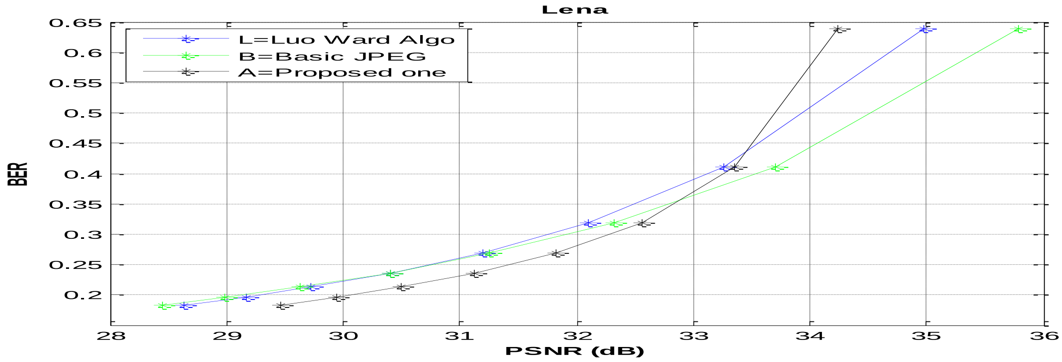

Fig. 1: Comparison of Algorithms on Lena image.

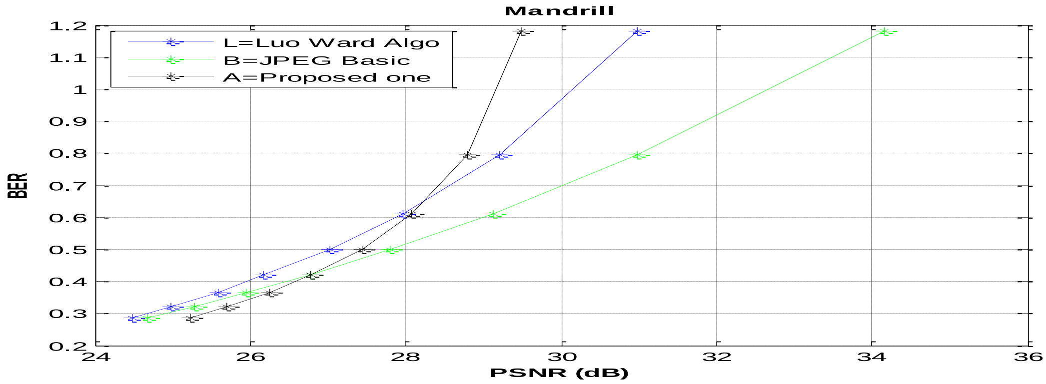

Fig. 2: Comparison of Algorithms on Mandrill image.

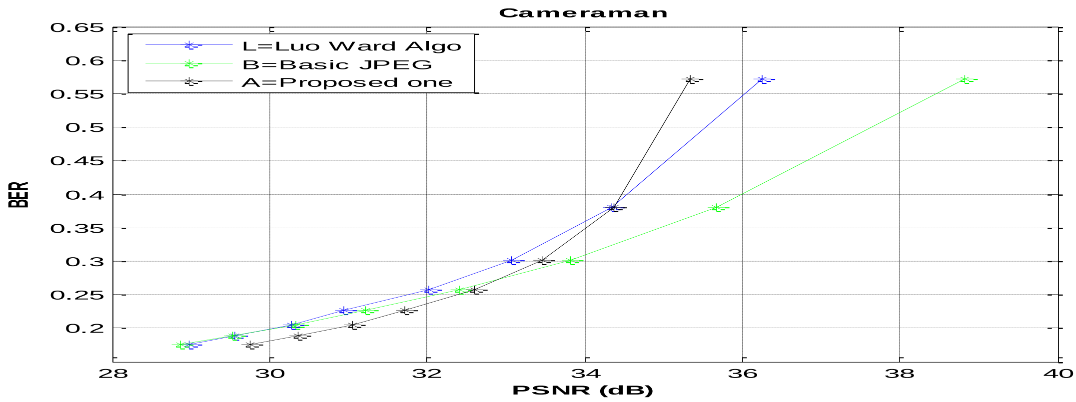

Fig. 3: Comparison of Algorithms on Cameraman image.

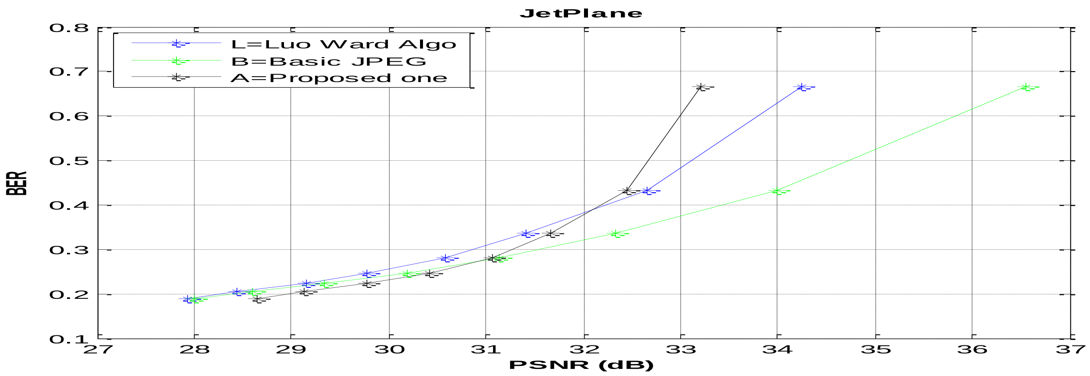

Fig. 4: Comparison of Algorithms on Jet Plane image.

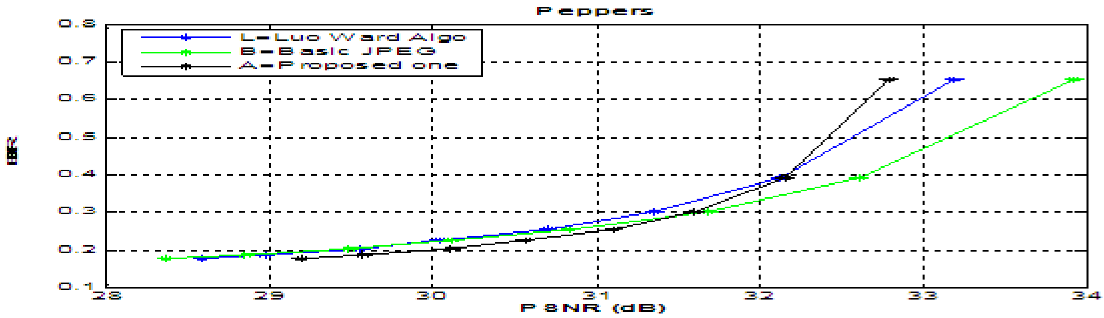

Fig. 5: Comparison of Algorithms on Peppers image.

From the Fig.1, Fig. 2, Fig. 3, Fig.4 and Fig.5, graphically it can easily be noted that the PSNR values of our algorithm increases with the bit rate decreases so our algorithm gives slightly better results as the bit rate decreases. PSNR, in fact the PSNR value achieved in our proposed algorithm was greater than both the PSNR values of decompressed image without Y. Luo's algorithm and with Y. Luo's algorithm respectively at low bit rates.

V. CONCLUSION

As the images suffers from the blocking artifacts when they are compressed at very low-bit rates by DCT-based algorithms, many research have so far suggested many algorithm to reduce the artifacts like blocking effects, blurring, ringing effects, in this thesis we so we presented an approach which is frequency domain post-processing approach in which we used low-pass, narrow band, anti-aliasing APDCT filter which suppressed the high frequency components and allowed to pass the low frequency components which resulted less blocking artifacts in images. But here we didn't consider the optimal design of better low-pass filters used after the decompression of image. Even though using our algorithm we attained better experimental values and better smoothness after compressing the images at very low bit-rates.

But apart from blocking, ringing is another annoying artifact that appears frequently in transform –based compressed images. The ringing effects comes in the images when the high frequency components are suppressed from the images so in future work the work can be performed to detect the ringing effect on some sharp-edged images and reduce the ringing effects from the DCT-based compressed images.

REFERENCES

[1] Y. Luo and R. K. Ward, "Removing the blocking artifacts of Block-Based DCT compressed images", IEEE transactions on image processing, Vol. 12, No.7, July 2003.

[2] Cheng-You, Zheng-Xin Hou, Kai He, Ai-Ping Yang "JPEG-Based Image Coding Algorithm at Low Bit Rates with Down-Sampling and Interpolation", Wireless Communications, Networking and Mobile Computing, 2008. WiCOM '08. 4th International Conference on 12-14 Oct. 2008.

[3] Z. X. Hou and X. Yang, "The all phase DFT filter", proceedings of the 10th IEEE Digital Signal Processing (DSP) Workshop and the 2nd IEEE signal Processing Education (SPE) Workshop, Pine Mountain, Georgia, USA, pp. 221-226. Oct. 2002.

[4] Z. X. Hou, "The construction of the three kinds of 2-dimensional superimpose digital filter," Journal of Tianjin University, Vol. 18, no. 1, pp. 29-41, Jan. 1985.

[5] K. Sayood, "Introduction to Data Compression", 3rd Edition, Elsevier, 2006.

[6] R. C. Gonzalez, R. E. Woods, S. L. Eddins, "Digital image processing using MATLAB", 5th Edition, Pearson, 2009.

[7] Y. Yang, N. P. Galatsanos, "Removal of Compression Artifacts Using Projections Onto Convex Sets and Line Process Modeling", IEEE Transaction on image processing, Vol. 6,No. 10,pp.1345-1357,Oct. 1997.

[8] Mr. S.V Viraktamath, Dr. G.V. Attimarad, "Performance analysis of JPEG Algorithm", proceedings of 2011 international conference on signal processing, communication, computing and networking technologies (ICSCCN 2011).

[9] Y. Yang,N.P. Galatsanos, A.K. Katsaggelos, "Regularised reconstruction to reduce blocking artifacts of block discrete cosine transform compressed image", IEEE transaction. Circuit and Systems for Video Tech.3 (December 1993) 421-432.

[10] A. Zakhor, "Iterative procedures for reduction of blocking effects in transform image coding", IEEE Trans. Circuit and System for Video Tech. 2(March 1992) 91-95.

[11] G. Aharoni, A. Averbuch, R. Coifman, M. Israeli, "Local Cosine transform- A method for the reduction of the blocking effect in JPEG", J. Of Math. Imaging and vision 3 (1993) 7-38.

[12] H.S Malvar, D.H. Staelin, "The LOT: transform coding without blocking effects", IEEE trans. Acoust Speech signal process. 37(Apri 1989) 553-559.

[13] B. Zeng, "Reduction of blocking effect in DCT-coded images using zero-masking techniques", signal processing 79(1999), 205-211.