An Approach to Abate Artifacts from Block Transform Colored Images

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***Abstract*— Image Compression is the process to reduce the size of the graphics file for transmission and storage without degrading its quality to an unacceptable level. The compression process is carried out by using the mathematical transformation known as Discrete Cosine Transform (DCT). A major drawback of DCT is that the decoded image exhibit visually annoying artifacts along the block boundaries. This paper presents a simple and effective method to reduce these artifacts. The artifacts are removed by applying the smoothing filter which manipulates the pixel values based on some criteria. The performance of proposed method is evaluated by using parameters like PSNR, MSE, RMSE and BER. The results reveal that the presented method reduces the artifacts and improves both the subjective and objective quality of an image.**

***Keywords*— Image Compression, DCT, Artifacts, Smoothing, PSNR, MSE, RMSE and BER.**

I. INTRODUCTION

Images play a vital role in today's age of concise information. The field of image processing continue to grow, with the development of new applications. In order to accommodate with the limited bandwidth of the Internet and the storage space, image compression techniques play the vital role. Compression is the process of representing information in a compact form. The goal of any compression technique is to reduce the bit rate for transmission and storage while maintaining the acceptable fidelity or data quality. Due to the increasing traffic caused by multimedia information and digitized form of representation of images, image compression have become a necessity [1]. The image compression improves the storage efficiency, communication speed and security [6].

To compress data, it is important to recognize redundancies in data, in the form of coding redundancy, inter-pixel redundancy, and psycho-visual redundancy. Data redundancies occur when unnecessary data is used to represent source information. Compression is achieved when one or more of these types of redundancies are reduced. Intuitively, removing unnecessary data will decrease the size of the data, without losing any important information. However, this is not the case for psycho-visual redundancy [2].

A compression artifact is a noticeable distortion of media which may be an image, audio or video, due to the application of an overly aggressive or inappropriate lossy data compression algorithm. These lossy data compression schemes discard some data to simplify the media sufficiently to store it in the desired space (data-rate). If there is not enough data in the compressed version to reproduce the original with acceptable fidelity, artifacts will result. The artifacts such as over smoothing of images, degradation due to quantization errors, ringing effects, blurring of images, blocking noise, image features irregularities etc. So to overcome these artifacts, various methods are used [3]. This paper presents a simple method to abate these artifacts.

II. IMAGE COMPRESSION USING DISCRETE COSINE TRANSFORM

A Discrete Cosine Transform (DCT) is a finite sequence of data points represented in terms of a sum of cosine functions oscillating at different frequencies. The DCT is used for two international image and video compression standards, Joint Photographic Experts Group (JPEG) and Motion Picture Experts Group (MPEG).

A. The Two-Dimensional DCT

The basic operation of this transform is to transform from spatial domain to frequency domain. Thus, it transforms the set of sample points into a set of frequency values that describes exactly the same image [8]. The 2-D DCT is given as [4]:

$$C(u,v) = \alpha(u)\alpha(v)\sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)\cos\frac{\pi(2x+1)u}{2N}\cos\frac{\pi(2y+1)v}{2N}$$

For u, v=*0, 1, 2, ……N-1* and $\alpha(u), \alpha(v)$ are defined as:

$$\alpha(u) = \begin{cases} \frac{1}{\sqrt{N}}, & u = 0 \\ \frac{\sqrt{2}}{\sqrt{N}}, & 1 \le u \le N-1 \end{cases}$$

$$\alpha(v) = \begin{cases} \frac{1}{\sqrt{N}}, & v = 0 \\ \frac{\sqrt{2}}{\sqrt{N}}, & 1 \le v \le N-1 \end{cases}$$

The DCT is used to concentrate information for making it useful for image compression applications. IDCT computes the two-dimensional inverse DCT using [4]:

$$f(x,y)=\sum_{u=0}^{N-1}\sum_{v=0}^{N-1}\alpha(u)\alpha(v)\,C(u,v)\cos\frac{\pi(2x+1)u}{2N}\cos\frac{\pi(2y+1)v}{2N}$$

DCT divides an image into 8x8 blocks and process each block independently to convert the image pixels into transform coefficients. Thus it reduces the redundancy between the neighbouring pixels. DCT is the fast transformation having $N\log_2 N$ complexity. It has excellent energy compaction and requires less number of transformation coefficients to reconstruct the image. The DCT can be computed in two steps by separate operation on rows and columns. The discrete cosine transform is a special case of the Fourier transform in which the sine components are eliminated [5]. Even though DCT is easy to implement and has less complexity, it causes an image to exhibit visually annoying artifacts due to independent processing of each block which does not take into account the existing correlations among the adjacent block pixels.

III. PROCEDURE TO REDUCE ARTIFACTS

It is clear from above discussion that the image data is dealt block by block basis. DCT is applied on each block independently [7]. Because of this fact, blocking artifacts such as blurring of images, blocking noise came into existence representing the lossy nature of DCT technique.

In this research paper we will learn to reduce these blocking artifacts using smoothing filter. We make an attempt to smooth out the differences that exists between the blocks. If the absolute difference between the adjacent pixels is less than threshold, then there will be no change in pixel values else we compute the average difference between these pixels. If the two pixels differ in value, then smooth out the difference by adding or subtracting the value of average difference from the neighboring six pixels of given 8x8 blocks. The above mentioned criterion is applied on both horizontal and vertical directions.

A. Performance Evaluation

In this section, we calculate the performance of presented method. The parameters used to evaluate the quality of reconstructed image are PSNR, MSE, RMSE and BER.

1) Peak Signal to Noise Ratio (PSNR): The higher the PSNR, the smaller is the difference between the restored image and the original image and the restored image is considered to be better. It calculates the ratio between the maximum possible power of signal and the power of corrupting noise that affects the fidelity of its representation. The PSNR is computed as:

$$PSNR = 10\log_{10}\frac{255^2}{MSE}$$

2) Mean Square Error (MSE): The value of MSE should be less, which means that the pixel intensity of the input and output image should be as close as possible. It is computed by averaging the squared intensity differences of the original image and its reconstructed image. The MSE is given as:

$$MSE=\frac{1}{MN}\sum_{j=1}^{M}\sum_{k=1}^{N}(x_{j,k}-y_{j,k})^2$$

M and *N* are rows and columns of the image. $x_{j,k}$ is the original image and $y_{j,k}$ is the corresponding output image.

3) Root Mean Square Error (RMSE): The large value of RMSE means that image is poor quality. It is calculated by taking the square root of the averaged squared intensity difference of the distorted and reference image. RMSE is defined as follow:

$$RMSE=\sqrt{\frac{\sum_{j=1}^{M}\sum_{k=1}^{N}(x_{j,k}-y_{j,k})^2}{MN}}$$

4) *Bit Error Rate (BER)*: The lower the BER, the better is the quality of the reconstructed image. It determines how many of the received bits are in error. BER is calculated by taking the inverse of the Peak Signal to Noise Ratio. BER is calculated as:

$$BER=\frac{1}{PSNR}$$

B. Results and Discussion

Ten colored images have been selected for verifying the validity of presented method. All the images are 512x512.jpg images and comparative results are defined using the performance indices PSNR, MSE, RMSE and BER.

The presented method improves both the subjective and objective quality of the images. The improvement in the objective quality of Tree.jpg image after the application of the proposed method is shown in Fig. 1.

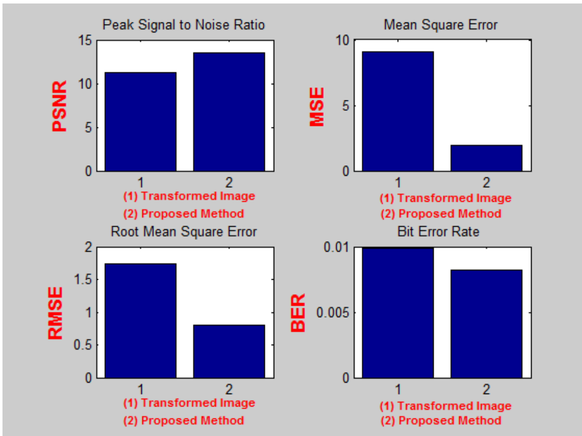

Fig. 1 Graph shows PSNR, MSE, RMSE and BER of Tree.jpg Image

It is observed from the exhibit that the value of PSNR has improved from 11.2619 to 13.4864. The value of MSE is decreased from 9.0656 to 1.9500. Exhibit also reveals that the value of RMSE and BER are reduced from 1.7383 to 0.8062 and 0.0099 to 0.0082 respectively.

Fig. 2 and Fig. 3 show the improvement in the subjective quality of the Tree.jpg image. Fig. 2 shows the transformed image and Fig. 3 shows the image reconstructed image after the application of presented method.

Fig. 2 Transformed Tree.jpg Image

Fig. 3 Reconstructed Tree.jpg Image

Fig. 4 represents the graph showing the comparison of Peak Signal to Noise Ratio for different images. The PSNR for images obtained after block transformation is represented by blue color and the PSNR for the images obtained by the application of proposed method is shown by red color. It is clear from the plot that there is increase in PSNR value of images with the use of proposed method. This represents the improvement in the objective quality of images.

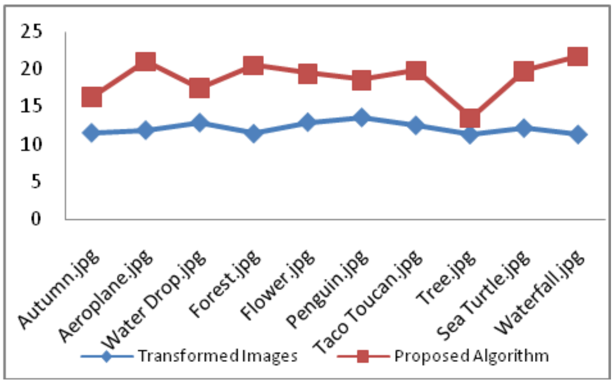

Fig. 4 Comparison of PSNR for Different Images

The exhibit shown in Fig. 5 illustrates the relationship between MSE and various images. The top-most line (blue) represents the MSE of block transformed images and the bottom line (red) represents the MSE of proposed method. This reveals that the MSE of proposed method is less than MSE of transformed images. This fact represents the validity of proposed technique.

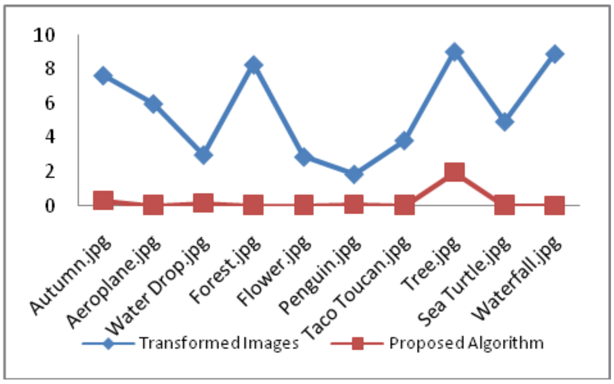

Fig. 5 Comparison of MSE for Different Images

Fig. 6 represents the graph showing the comparison of RMSE for different images. The RMSE for images obtained after block transformation is represented by blue color and the PSNR for the images obtained by the application of proposed procedure is shown by red color. It is clear from the plot that there is decrease in RMSE value of images with the use of proposed method.

Fig. 6 Comparison of RMSE for Different Images

The exhibit shown in Fig. 7 illustrates the relationship between BER and various images. The top-most line (blue) represents the BER of block transformed images and the bottom line (red) represents the BER of proposed method. This reveals that the BER of proposed method is less than BER of transformed images. This fact represents the validity of proposed technique.

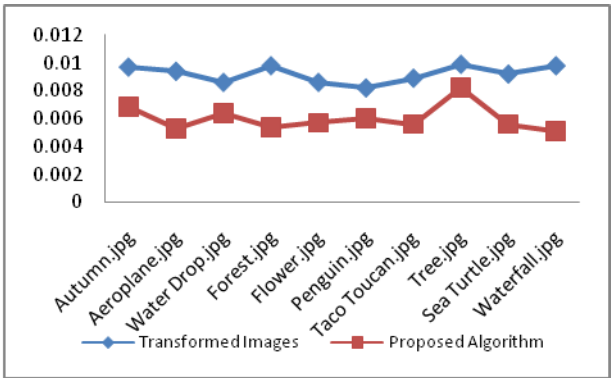

Fig. 7 Comparison of BER for Different Images

IV. CONCLUSIONS

Compression of digital image an important role in reducing the transmission and storage cost for visual communication. DCT is used for transformation in image compression standard. DCT performs efficiently at medium bit rates. Disadvantage with DCT is that only spatial correlation of the pixels inside the single 2-D block is considered and the correlation from the pixels of the neighboring blocks is neglected. This gives rise to visually annoying artifacts in the colored images. In this dissertation, we propose a post-processing algorithm which substantially improves the decoded image quality for transformed images by reducing artifacts. The performance of the proposed algorithm was measured by the PSNR, MSE, RMSE and BER of the post-processed image. The measured PSNR of the proposed post-processing method showed an increase for various test images. The result also reveals the decrease in the MSE, RMSE and BER. The higher the PSNR and lower the MSE, RMSE and BER, the better the quality of the reconstructed image.

Thus the proposed post-processing algorithm effectively reduces the artifacts and has increased the subjective as well as objective quality of the images.

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