

SUPPRESSION OF BLOCKING ARTIFACT IN COMPRESSED IMAGE

*A thesis submitted in partial fulfilment
of the requirements for the award of the degree of*

Master of Technology

in

Electronics and Communication Engineering

(Specialization: Signal & Image Processing)

by

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National Institute of Technology

Rourkela - 769008, Odisha, INDIA

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***Dedicated
To
BABAJJ,
And My Family***



Department of Electronics & Communication Engineering

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Rourkela - 769008, Odisha, INDIA

CERTIFICATE

This is to certify that the Thesis Report entitled “**Suppression Of Blocking Artifact In Compressed Image**” submitted by **Ms. JYOTI MISHRA** bearing roll no. **212EC6440** in partial fulfilment of the requirements for the award of Master of Technology in Electronics and Communication Engineering with specialization in “**Signal & Image Processing**” during session 2012-2014 at National Institute of Technology, Rourkela is an credible work carried out by her under my supervision and direction.

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ABSTRACT

Image compression is actually major content for certain perspectives in the area of interactive media communication. Image processing is the mechanism for handling different kinds of images, processed images can be stored routinely and conveyance of such kind of images from one place to another place becomes simple to the user. By using image compression technique we are able to represent the image with lesser number of data bits. image compression execution can cut down the bandwidth and the volume of the data to be transmitted. (BDCT) block-based discrete cosine transform is long establish used transform for the two static and uninterrupted images. While we compress any kind of image by lossy type of image compression technique then there will be loss of data bits, we have to confrontation unwanted artifacts ringing and blocking artifacts and when we want to restore such kind of image then we face problem of blurring of images, which is sometimes called as the annoying artifacts problem near the block of the image. The recovered images from jpeg compression create blocking artifact near block boundaries of the image in high compression.

Artifacts take on several forms in images. We are going to focus on blocking artifacts at medium and high level compression. Various types of images can be processed and we can diminish blocking artifacts up to tolerable level. Some standard techniques MPEG and JPEG are used in video and image processing field respectively for the compression. Lossy image compression technique is used in photographic images because loss of bits is tolerable, Since last few decades, image compression in real time applications has been a provocative field for image processing professionals. To recover original image decompression succeed by the different post processing techniques. High quality image communication with low-bit rate is securing exclusive attention in the nearly created utilizations such as video conferencing, video phone and interactive TV and latest utilizations such as telemedicine, picture archiving, and communications scheme(PACS).

The reduction in blocking artifact is classified by three parameters, PSNR (Peak Signal to Noise Ratio), MSSIM (Mean structure similarity index based on human visual perception) and block boundary measure (BBM).

Keywords- DCT, JPEG, Blocking Artifacts, PSNR, BBM, MSSIM, HVS

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INDEX OF ABBREVIATIONS

DCT	Discrete Cosine Transformation
PSNR	Peak Signal to Noise Ratio
BBM	Block Based Measurement
MSSIM	Mean structure similarity index based on human visual perception
BDCT	Block-Based Discrete Cosine Transformation
POCS	Projection - Onto Convex Set
JPEG	Joint photographic Expert Group
MPEG	Moving Picture Expert Group

Chapter 1

Introduction



➤ *INTRODUCTION*

➤ *OVERVIEW*

➤ *LITERATURE REVIEW*

➤ *OBJECTIVES*

➤ *LAYOUT OF THE THESIS*

1.1. Introduction

The Block-Based Discrete cosine Transform is the generally used transform for the two static and continuously dynamic images. High compression ratios are frequently obtained by canceling the data about the BDCT coefficients that is calculated as worthless and retrieve images that give introduction of the visually *blocking Artifacts*.

Image compression is an ambiguous matter for lots of utilizations in the area of visual communications. Image compression is a very significant individual for distinct path in the area of interactive-media communication for minimization of the storage and transference price while protecting image quality. A lot of impressive techniques have been refined for many different utilizations. The joint photographic expert group (JPEG) has been proposed for continuously still images.

Among the many valuable image compression accesses, Block-Based Discrete cosine Transform (BDCT) is frequently used transform for the two static and continuously dynamic images in lossy image compression. The Block-Based Discrete cosine Transform (BDCT) theory is a basic integral of countless image and video compression standards. The Block-based Discrete Cosine Transform (DCT) is the ultimate attractive compression transformation and has been promoted as a major technique to compress digital image data like JPEG is for still images, MPEG for moving pictures, and H .261 for videophone or teleconference. The recreated images from JPEG compression develop blocking artifact near block boundaries of the image in high compression.it is through the medium of transformation and quantization of of each block image happens separately. The boundary region establishes between blocks of the compressed image .Blocking Artifacts and ringing Artifacts are genuine obstacle in Discrete cosine Transform based image compression ,Due to blocking artifact, there is exaggeration in picture quality or the visual quality. This is the considerable fault in the DCT

based compression system at low data bit rate. Blocking artifact is exposed by Human Visual System.

Visual image quality can be soberly enhanced by falling of the blocking artifact and the advancement in bit rate to get satisfied quality of image is very costly. Higher compression ratios can be managed with better picture quality if blocking artifacts are decreased. The recreated images from deeply compressed data has markable image degradation, like ringing and blocking artifact near the block of the image. Post-Processing resembles to be the utmost workable explanation because it doesn't need any subsist standard to be changed. The block based DCT compression outcome in visible artifact at block boundaries because of coarse quantization of the DCT coefficients boundary region between the blocks of the reconstructed image are remarked as smooth and non-smooth region. The blocking artifact in the smooth and non-smooth regions are detached by altering some DCT coefficients.

1.2. Overview

Blocking artifact is a fabricated architecture achieved from a array of images and it can be retrieved by finding out the analytical scheme between of pixels in the images. The numeric relation is the correlative system that relates the different image coordinate structure. By applying the applicable discrete cosine transformation and quantization operation of coefficients, it is achievable to recreate an image from jpeg compression produce blocking artifact near block boundaries of the image, in highly compressed. The conclusive image is the motivation for removal of blocking artifact. Various steps in suppression of blocking artifact are JPEG Compression in which, DCT, Quantization and transform image coding occur. DCT used because of better energy compaction and de-correlation properties. DCT used for converting signal into elementary frequency components. Most approaches to discrete cosine

transformation require nearly exact overlap between pixel and identical exposures to produce seamless results .DCT is source encoder or linear transformer.

The second is: Quantization is the process at encoding side means separating of input data range into a smaller group of values at the encoder side .it reduces number of bits necessary to save the transform coefficients by minimizing precision. Quantization perform on every coefficients independently is Scalar Quantization. Image compression for processing various kinds of images, processed images can be stored conveniently and transmission of such kind of images from one place to another place becomes easy to the user in which the final information is received from the combination of sources like in DCT of 8*8 image, quantization of coefficients, transform coding and the reverse process of forward step.

Discrete cosine transformation is necessary for removal of redundancy between adjoining pixels. This leads to uncorrelated transform coefficients which can be encoded separately, energy compaction property of DCT is for highly correlated images. Uncorrelated images have its energy spread out and energy of correlation image is packed into low frequency region.

For quantization, with some existing fidelity criterion the accuracy of the transformer's output decreases by it and also reduces the psycho visual redundancies of the input image. We can't reverse this operation and must be neglected if compression is desired.

In this we convert input data from one format to another to minimize inter pixel-redundancies in the input image. The benefit of the transform based coding system is depends upon this thing that lots of resulting coefficients for most natural image has small magnitude and may be quantized beyond creating powerful distortion in the decoded image. If the potential of compression information in some coefficients is higher, than the performance is superior.

In this transformation process, blocking occur at encoding side because of coarse quantization of DCT coefficients. Removal of block artifact is a process of suppressing the overlapped pixel of an image in order to create a low bit rate or compressed image.

1.3. Applications

Some of the application areas are as follows:

- ✓ The digitized recovering of information
- ✓ The data transmission cost
- ✓ The compression of enormous air scape and satellite remote sensing image
- ✓ Meteorological and background monitoring;
- ✓ Sea-bottom and geological study
- ✓ Medicine and scientific micro-fragment image
- ✓ The 3D rebuilding of objects
- ✓ Video compression, video search browse, and video edit, etc.
- ✓ Military surveillance and taking testimony.
- ✓ It is typically executed through the use of computer software;

1.4. Literature Review

Algorithms that allow images to be regulated and seamlessly meshed together are among the oldest most commonly used in computer vision.

Y. L. Lee, H. C. Kim, and H. W. Park,[6] proposed the signal adaptive filtering technique which is used to define high-quality artifact reduction even for the most challenging

cases of High Compressed Video. The technique also helps in removing inter pixel blocking during complex motion in video.

C. Chen and Y.Q. Shi, in their paper [8] proposed a method of “JPEG image steg analysis employing the two inter-block and intra-block correlations.it It uses the visual attention model to extract blurring region, and to use the regional removing artifact technology to achieve blocking artefact free compressed image. The paper automatically and accurately obtains smooth regions and also decreases the complexity of the removing annoying artifact and thus improves the quality of image compression.

A. Zakhor, in the paper [9] proposed “Iterative strategy for Minimization of blocking artifact in Transform image coding and,” and compression technique to increase PSNR. His work is on standard image.

D. G. Sampson, D. V. Papadimitriou, and C. Chamzas,[10] proposed the work with a complete estimation procedure along with data groups, ground truth information and performance matrices on “Post-processing of block coded images at low bit-rates,”

J. Chou, M. Crouse, and K. Ramchadran, [12] proposed A simple algorithm for Minimizing blocking artifact in block transform coded images. It is most useful in real-time application “

K. R. Rao and P. Yip,[13] proposed techniques for Discrete Cosine Transform for JPEG implementation and Algorithms, for the removal of blocking artefact with many Advantages, and Applications for the still as well as moving objects.

A. Gersho and R. M. Gray, [14] proposed the work for Vector Quantization and Signal Compression.,this useful work was able to achieve good compression ratio in video and images.

R. L. de Queiroz, [15] Processed JPEG-compressed images and documents for the segmentation of images and W. B. Pennebaker, J. L. Mitchell, proposed technique for Still Image Data Compression or JPEG standard..

T. Jarske, P. Haavisto, and I. Defee, [18] proposed a method called Post-filtering method. This is a technique of filtering the coefficients. These features are from discrete cosine transformation for macro blocks, for minimizing blocking effects from coded images,” and also to identify pixel invariant features in an image and to use the same for locating an object in an image. He also proposed a method to determine distinctive image features from scale invariant key points.

This algorithm is robust to scale and pixel variation. The algorithm provides the pixel points which are accurate, stable, reliable, efficient and fast. In the algorithm he proposed a blocking artifact removal method which also includes JPEG compression.

G. K. Wallace, in their paper [17] proposed a method for generating The JPEG still-picture compression standard,” image using horizontal, vertical, and general manifold. Manifold projection helps in the fast creation of low distorted panorama removal of blocks near edges, under very slight camera motions.

H.C.Reeve and J.S.Lim, [19] proposed the work tests few matrices rather a single one to certify the reliability of the removing blocks using JPEG compression standard. The conductive metrics are all depends on easy pixel wise comparison, so the calculative simplicity protected.

J. G. Apostolopoulos and N. S. Jayantha, [20] proposed a technique “it was for the suppressing the annoying artifacts. He worked on the standard images for the convenience of the flash problem.

1.5. Objectives

Image compression is anticipated to diminish the number of bits necessary to show a without suffering quality Vision allows humans to analyze and be aware of our adjoining world. In this we compress the information and encounter unwanted artifact so the quality degraded. To upgrade the quality of image, we use removal of blocking artifact. Removal of blocking artefact helps in increasing the clear and compressed image. It provide us a lot of useful data that are required to extract valuable information not only from a single image but from video also. Since Removal of annoying artifact has been an emerging field which focuses JPEG Compression of an image in which ,DCT, Quantization and transform image coding on Moreover, the images not only contain the structure , shape and colour information about the picture, but also the possible camera motion, calibration and also on movements of objects in the scene.

There are a lot of existing removing blocking artifact algorithm and still research is going on. Each algorithm is considering a few variation in account while generating the output. So here improvement in the visual quality of image by improving the robust removing artifact algorithms considering the combined effect of rotation, illumination, noise variation and other minor variation. It is precisely this information that is to be produced in this thesis.

1.6. Layout of the Thesis

Chapter 2: JPEG Implementation

It introduces the Joint Photographic Expert Group Compression standard which is very famous and frequently used image compression standard. It includes basic process of image compression, steps involved for the implementation. And at last, there is analysis and simulation using standard image.

Chapter 3: Removal of blocking artifact using Zero Masking Technique

In this chapter, Zero Masking algorithm is discussed, which is an algorithm to remove block artifacts. It discusses the basic steps involved in the algorithm. Also the simulation and discussion of result has been done in this section.

Chapter 4: Removal of blocking artifact using Image Segmentation

This chapter describes about the Removal of blocking artefact using Image Segmentation technique, the title of the thesis. It discusses about the proposed technique which works .It includes the basic process involved in the technique. Moreover it analyses the simulation results. The results are discussed and shown with the help of comparison table.

Chapter 5: Conclusion

It concludes the research work of the whole thesis, and analyse and outlooks for future research.

Chapter 2

JPEG Implementation



- *GENERAL CONCEPT*
- *FLOW CHART*
- *IMAGE COMPRESSION*
- *DCT*
- *QUANTIZATION*
- *TRANSFORM IMAGE CODING*
- *SIMULATION USING MATLAB*
- *CONCLUSION*

2.1. General Concept

Jpeg is an image compression standard employed for saving or storing images in compressed scheme. It exemplified as Joint Photographic Experts Group. The impressive quality of JPEG is that it accomplishes high compression ratio with very short loss in visual quality. JPEG scheme is fully attractive and is tested in lot of devices like Digital camera. This is also the scheme of preference when swapping huge sized images in a bandwidth subjected scene like Internet. JPEG compression is suitable for photographs with smooth variations of tone and color. JPEG in image with lots of edges and acute changes can lead lots of artifact in the resultant image. Image files saved in the JPEG format commonly have the extensions such as .jpg, .jpeg or .jpe.

2.2. Flow Chart

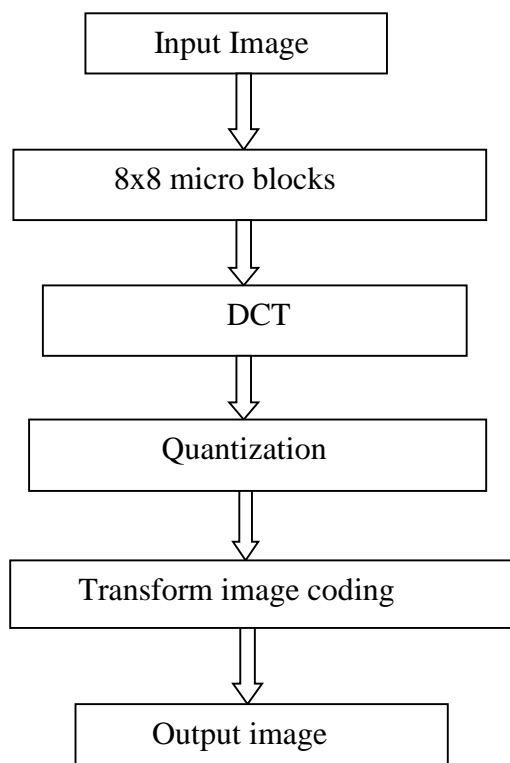


Fig 2.1 Flow chart for JPEG compression

2.3. Image Compression

The volume of data correlated with visual information is so large that its depot would desire excessive storage space. Although the dimension of certain storage media are massive, their admittance velocity are usually inversely proportional to their size. Normal television images develops bit rates exceeding 10 million bytes per second. Some extra image sources that develop even higher bit rates. Storage in other words save and transmission of such information need huge size and/or bandwidth, which could be very costly. Image data compression techniques are involved with decrease the number of data bits needed to save or transfer images beyond any observable losing information. Image transmission purpose in broad- cast TV, remote sensing via satellite, aircraft, radar or sonar.Tele-conferencing, computer communication, and facsimile transmission. Image saving is needed utmost frequently for educational and business records, medical carbons used in patient monitoring systems, etc. Due to their lot of applications, data bit compression is of tremendous extensive in digital image processing. Tele-vision picture develop bit rates exceeding 10 million bytes per second. There are different picture origins that develop greater bit rates. Safely stock and transfer of such data need excessive size and bandwidth which could be very costly. Data Redundancy is the pivotal matter in digital image compression. Assume p and q signify the number of data bits bearing units in two data sets that show the equal data bit, then the compression ratio is described as:

$$CR = p/q \quad (2.1)$$

In the same, relative data redundancy RD can be represented as pursues:

$$RD = 1 - 1/CR \quad (2.2)$$

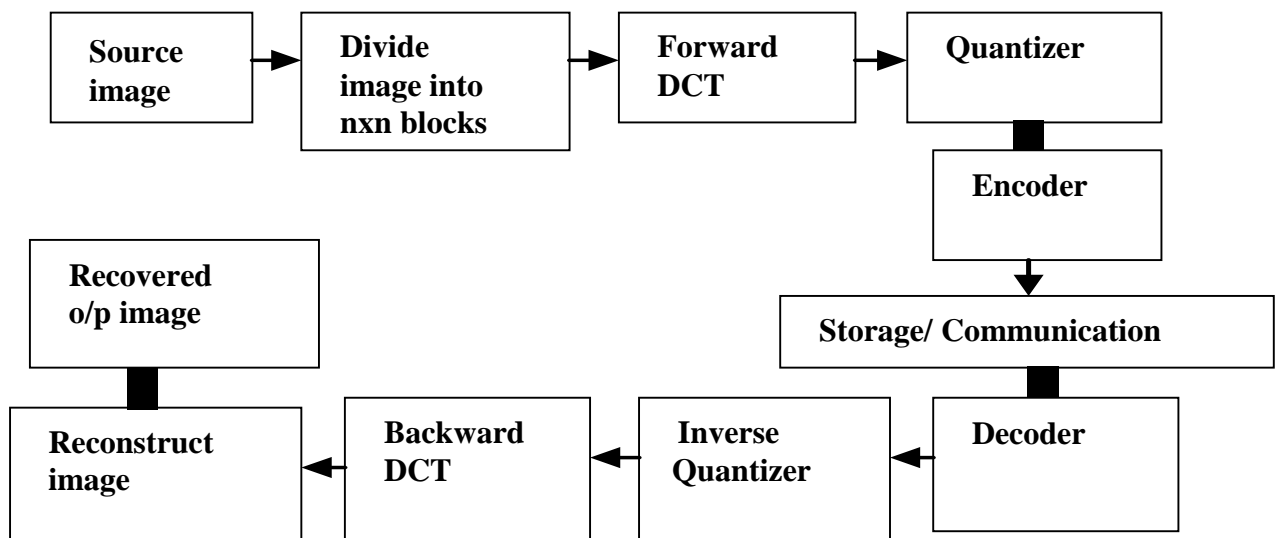


Fig2.2 -Block diagram of compression and decompression

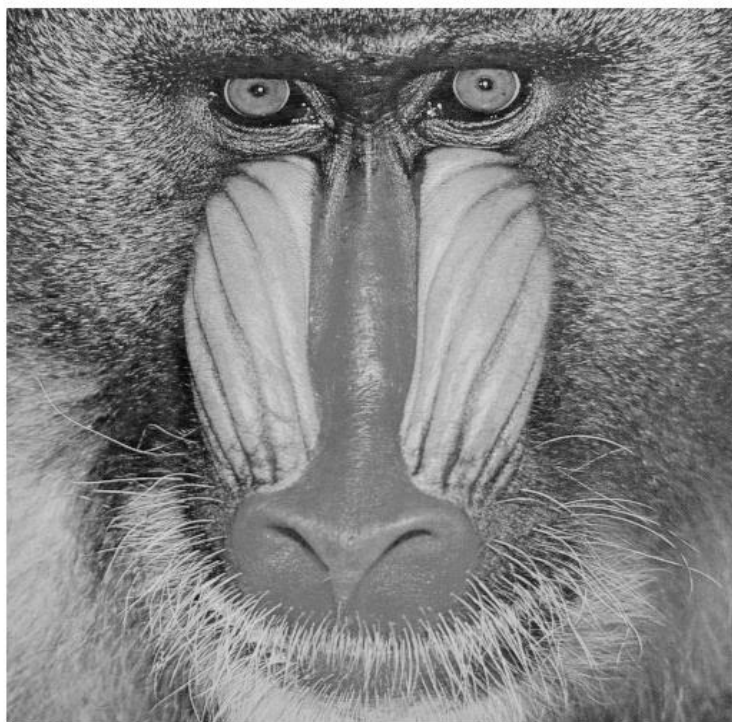


Fig.2.3 Original input Baboon Image

2.4. DCT

The discrete cosine transform is rapid transform that proceeds an information and transforms it into continuous combination of weighted basis function, these basis functions are typically the frequency, such as sine waves. For image compression, it is frequently used and booming mechanism. It has magnificent energy compaction for deeply correlated data, which is remarkable to DFT. Each element of 8*8 block is changed to a frequency sphere account, employing an assigned, 2D type II discrete cosine transformation .1D DCT is represented as-

$$c(u) = a(u) \sum_{x=0}^{N-1} f(x) \cos[(2x+1)u\pi/2N] \quad (2.3)$$

where

$$u = 0, 1, 2, \dots, N-1$$

Inverse DCT is defined as:

$$f(x) = \sum_{u=0}^{N-1} a(u) c(u) \cos[(2x+1)u\pi/2N] \quad (2.4)$$

where-

$$x = 0, 1, 2, \dots, N-1$$

$$a(u) = \sqrt{\frac{1}{N}}, \text{ for } u = 0$$

$$a(u) = \sqrt{\frac{1}{N}} \text{ for } u = 1, 2, 3, \dots, N-1$$

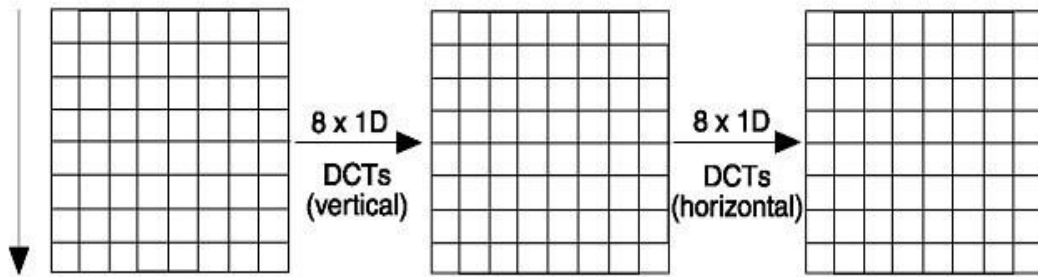


Fig.2.4 Block diagram for Computation of DCT.

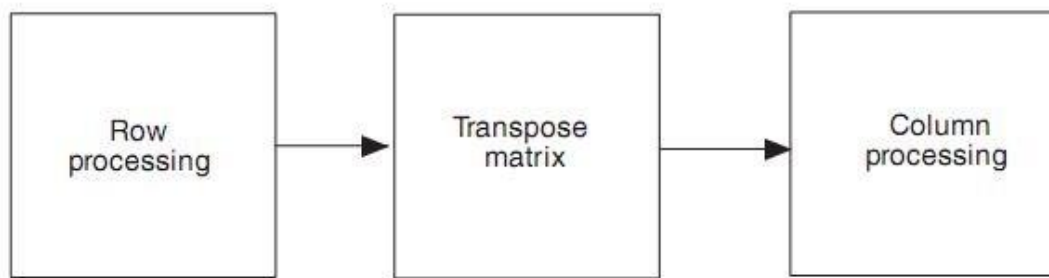


Fig.2.5 Three stages in implementing 2D DCT.

Suppose taking an example of an 8x8 sub block:

$$\begin{bmatrix} 52 & 55 & 61 & 66 & 70 & 61 & 64 & 73 \\ 63 & 59 & 55 & 90 & 109 & 85 & 69 & 72 \\ 62 & 59 & 68 & 113 & 144 & 104 & 66 & 73 \\ 63 & 58 & 71 & 122 & 154 & 106 & 70 & 69 \\ 67 & 61 & 68 & 104 & 126 & 88 & 68 & 70 \\ 79 & 65 & 60 & 70 & 77 & 68 & 58 & 75 \\ 85 & 71 & 64 & 59 & 55 & 61 & 65 & 83 \\ 87 & 79 & 69 & 68 & 65 & 76 & 78 & 94 \end{bmatrix}$$

Since calculating the DCT of the sub-block, its gray values converted from a specific dimension to one gather over zero. For an 8 bit image every pixel has 256 available amount [0,255].

To gather over zero it is necessary to subtract by half the number of possible values 128. Subtracting 128 from each pixel value yields pixel value on [-128,127].

$$\begin{bmatrix} -415 & -30 & -61 & 27 & 56 & -20 & -2 & 0 \\ 4 & -22 & -61 & 10 & 13 & -7 & -9 & 5 \\ -47 & 7 & 77 & -25 & -29 & 10 & 5 & -6 \\ -49 & 12 & 34 & -15 & -10 & 6 & 2 & 2 \\ 12 & -7 & -13 & -4 & -2 & 2 & -3 & 3 \\ -8 & 3 & 2 & -6 & -2 & 1 & 4 & 2 \\ -1 & 0 & 0 & -2 & -1 & -3 & 4 & -1 \\ 0 & 0 & -1 & -4 & -1 & 0 & 1 & 2 \end{bmatrix}$$

Mark the relatively broad value of the left corner. This is the Direct current coefficient. The resting 63 coefficient are labeled alternative current coefficients. The profit of the DCT is its habit to combined almost the coefficient in one corner of the outcome, it can be notice on top.

The quantization mark to succeed highlight this development although together decreasing the total amount of the Discrete Cosine Transform coefficients, producing a component that is simple to shorten smoothly at the entropy phase.

DCT impermanently develops the bit -base of the image, after all DCT coefficients of an 8 bit image adopt 11 or higher bits (building upon on loyalty of the DCT computation) to save. It can affect the codec to briefly operate 16-bit bins to influence these coefficient, by doing double the amount of the image sample at this mark, they are oftenly decreased back to 8 bit by the quantization footprint. The provisional improvement in capacity at this point is not an achievement matter for maximum JPEG implementations, for the reason that generally isolated a very limited section of the image is saved in entire DCT form at any provided second for the time being image encoding and decoding mechanism

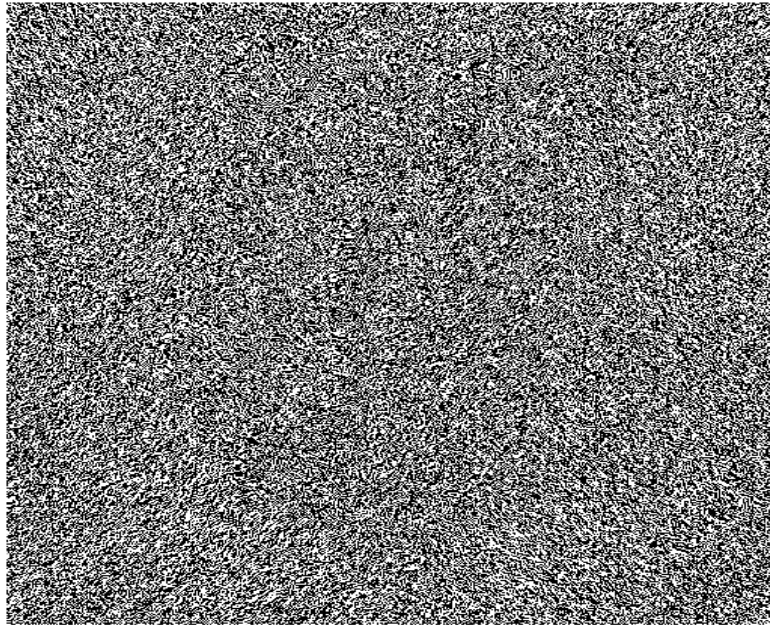


Fig 2.3: DCT of Baboon image

2.5. Quantization

The civilized eye view is better at noticing cramped changes in shine done with a comparatively huge field, but not so satisfactory at differentiating the specific durability of an immense frequency brightness fluctuation. A quantizer easily decreases the number of data bits required to save the transformed coefficient through decreasing the precision of those values. Seeing that it is many -to- one mapping,

This is a lossy mechanism and is the prime origin of compression is an encoder side. Quantizer may be executed on separate coefficient, which is accepted as *Scalar Quantizer* (SQ). Quantization can also be executed on a set of coefficients simultaneously, and this is accepted as *Vector Quantizer* (VQ).

This permits to extremely decrease the extent of data material in high frequency elements. This is performed by easily splitting every element in frequency domain by a stable

value for the same element, and then spinning to the most neighbouring integer. This is the major lossy process in the full procedure. As an outcome of this, it is generally the bin that countless the greater frequency elements are circular to zero, and countless rest components turn into lesser positive and negative numbers, which share lot of less data bits to save.

A general Quantization matrix:

$$\begin{bmatrix} 16 & 11 & 10 & 16 & 24 & 40 & 51 & 61 \\ 12 & 12 & 14 & 19 & 26 & 58 & 60 & 55 \\ 14 & 13 & 16 & 24 & 40 & 57 & 69 & 56 \\ 14 & 17 & 22 & 29 & 51 & 87 & 80 & 62 \\ 18 & 22 & 37 & 56 & 68 & 109 & 103 & 77 \\ 24 & 35 & 55 & 64 & 81 & 104 & 113 & 92 \\ 49 & 64 & 78 & 87 & 103 & 121 & 120 & 101 \\ 72 & 92 & 95 & 98 & 112 & 100 & 103 & 99 \end{bmatrix}$$

The quantization DCT coefficient are calculated along-

$$B(j,k) = \text{round} (G(j,k)/Q(j,k)) \quad (2.5)$$

for $j = 0,1,2 \dots N_1 - 1$;

$k = 0,1,2 \dots N_2 - 1$

Where-

G –DCT coefficients of un-quantized

Q – Matrix for the quantization

B - DCT coefficients of quantization matrix.

Testing quantization matrix with DCT coefficient matrix from upper outcomes in:

$$\begin{bmatrix} -26 & -3 & -6 & 2 & 2 & -1 & 0 & 0 \\ 0 & -2 & -4 & 1 & 1 & 0 & 0 & 0 \\ -3 & 1 & 5 & -1 & -1 & 0 & 0 & 0 \\ -4 & 1 & 2 & -1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

For the case, testing -415 (DCT coefficient) and circulating to the nearby

$$\text{round}\left(\frac{-415}{16}\right) = \text{round}(-25.9375) = -26 \quad (2.6)$$



Fig: 2.4 Error in baboon Image

2.6. Transform image coding

Execute discrete cosine transform to each of the pixel values to receive a group of transform coefficients. The main aim for the transformation of the pixels is to focus the image information or data cover a lot of pixels to a minor number of pixels and then the pixels that do not enclose and suited data which can be neglected, hence decreasing the image range. Generally many transform adapted, those are any operation that are convertible so that we can restore the transformed amounts and should be efficient of focusing the picture data over a minor area.

A general lossy image compression scheme presented in figure, subsist of three jointly linked fundamentals:

- ✓ Source Encode
- ✓ Quantizer
- ✓ Entropy Encoder

An Entropy Encoder extra more shorten the quantized amount losslessly to provide comprehensive improved compression. Maximum frequently tested entropy encoders are Huffman encoder and arithmetic encoder, despite the fact for utilizations demanding for rapid run.

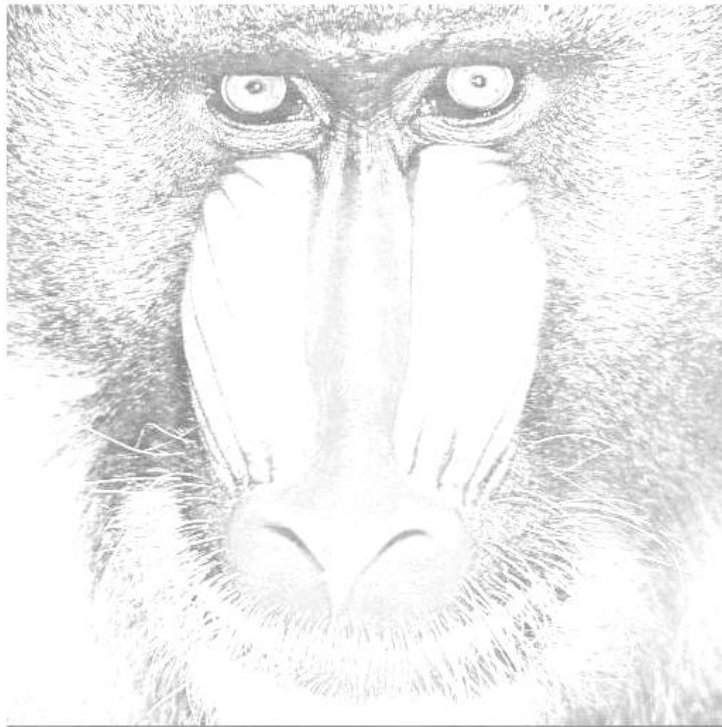


Fig 2.5: recovered baboon image

2.7. Simulation Results

For the task, we have selected the standard image Baboon for our examination objective. We partitioned the perfect image into 3×3 sub images. The leading two dimensional discrete cosine transformation is adapted for the entire pixel of individual sub image. Now the pixel that bear bottom data material that are ignored. So the amount of the pixel, which has value less than threshold value, is set to zero. For this operation we have selected the threshold value equivalent to 20. So the entire pixel that have value below 20 are mentioned as have value equivalent to zero.

After this Inverse Discrete Cosine Transformation is tested to entire the transformed pixel of sub image. Similar process is applied for the entire sub images. It is found that energy received from the compressed image is equivalent 95%. The image intensity was about 96%,

the Mean Square Error is 10dB. The program run time spend was around 1.2 and very important the compression ratio is 9.1. The algorithm suggested has been implemented in Matlab R2010a. Fig 2.3 is the input image for the test. JPEG Implementation has been practiced on these figure has been achieved as presented in Fig 2.4 is DCT of the input image, In Fig 2.7 error in image and in Fig 2.8, is recovered image.

2.8. Conclusion

For JPEG Implementation, the process Discrete Cosine Transform, quantization, and image encoding is a generally accepted and prosperous test for compression of digital image as it has the capacity to bear the highest data material in basic number of pixel to secure transmission time and price, it gives better outcome as well as properties like root mean square error, image intensity and run second is involved. So JPEG compression is frequently used for image and MPEG compression is for video compression.

Chapter 3

Zero Masking Technique for removal of Blocking Artifacts



- ***ZERO-MASKING TECHNIQUE FOR REMOVAL OF BLOCKING ARTIFACTS***
 - ***GENERAL CONCEPTION***
 - ***CONSTITUTION OF MICRO BLOCK***
 - ***DETECTING EDGES IN DCT FIELD***
 - ***ZERO MASKING METHOD***
 - ***ALGORITHM FOR ZERO MASKING***
 - ***SIMULATION USING MATLAB***
 - ***CONCLUSION***

3.1. General Conception

An innovative approach to minimise blocking artifacts in compressed image, which is situated on employing zero masking approach to DCT coefficients of few relocated image non-overlapped blocks of size 8x8.

3.2. Constitution of micro block

An unused approach to minimise blocking artifacts, is situated on employing zero masking approach to DCT coefficients of few relocated image data blocks. DCT is practiced to non-overlapped blocks of size 8x8. Entire DCT coefficients are quantized and encoded to produce binary data flow for transportation. DCT domain notice that noticeable boundaries between two adjoining blocks are basically adjust along the horizontal and vertical directions.

After this create a new data block (x, y) with the row and column pixels. These pixels consist of the primitive noticeable boundary in the intermediate point and standard it as a two dimensional step function corrupted by an independently and identically distributed noise with zero mean value and a less variance.

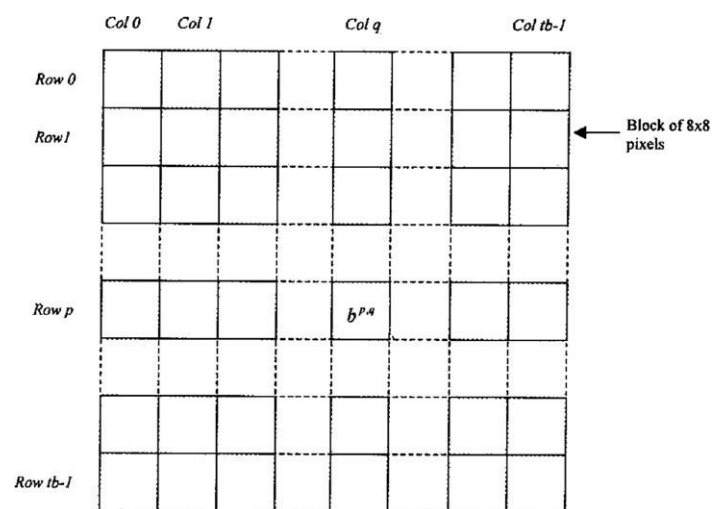


Fig 3.1 block formation with horizontal and vertical direction.

3.3. Detecting Edge in DCT Field

Discrete cosine transform domain notice that in coded image noticeable boundaries between two adjoining blocks are mainly aligned along the horizontal and vertical directions. Then create a different data block that consists of the initial noticeable boundary in the intermediate point and standard it as a two dimensional step function corrupted by an independently and identically distributed noise with zero mean value and a less variance. This type of deterioration possibly will influence the awareness of an end user.



Fig 3.2 Left is original image and right is compressed having block with .26bpp

3.4. Zero-Masking Technique

By applying DCT on such blocks, AC elements of powerful strength constantly occur in a few fixed points. Occupying on this information, we accordingly recommend to zero out some of these AC elements and exhibit that performing so can produce blocking artifact enough minor visible.

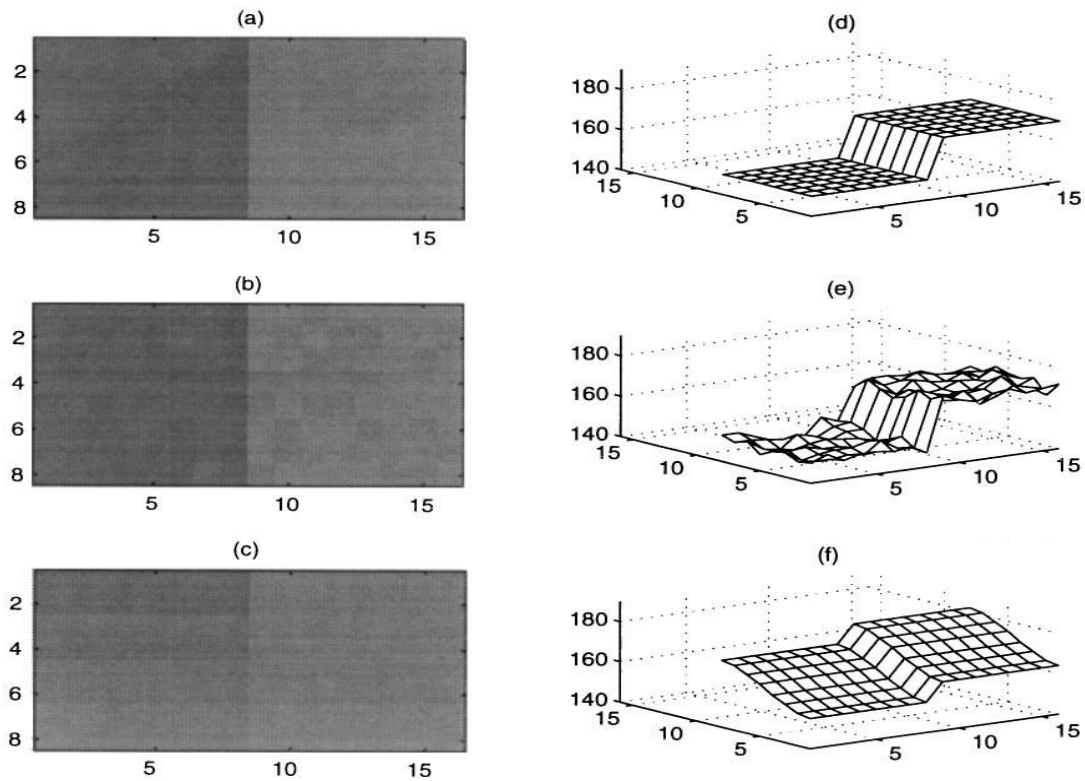


Fig 3.3 blocking model: The left column present pixels gray values and the right column present the comparable 3D design (a) And (d) is the case for noise free, (b) and (e) gray value with the variance $\sigma^2=5$ (c),(f) for the functional case.

By performing DCT 8x8, AC elements of powerful strength constantly occur at four points in the first row (0,j) for j=1,3,5,7. AC energy is 100% sealed within these four elements for noise free case. The blocking artifact response in the horizontal direction because of the occurrence of huge AC power at j= 1,3,5,7. To clear away blocking, we drop three elements $X_{0,3}$, $X_{0,5}$ and $X_{0,7}$ and this is for the horizontal case. In the meanwhile, as three AC elements have been set to zero, the continuous data block will be absolutely distinct from the initial. For the blocking artifact response in the vertical direction we transpose the DCT coefficients. So, three AC elements to be set zero are $X_{3,0}$, $X_{5,0}$ and $X_{7,0}$.

3.5. Algorithm For Zero Masking

- 1.) Choose an image
- 2.) Select C as the recurrence number.
- 3.) Set counter=1
- 4.) Select the direction (horizontal or vertical) and perform
- 5.) Create new 8x8 image blocks
- 6.) For each block, subroutine
 - I. DCT
 - II. Quantization of each block
 - III. Implementing zero masking to DCT coefficient
 - IV. Inverse DCT
- 7.) Diverse the direction and go on the procedure
- 8.) End



Fig 3.4 Input Image left with one iteration right with five Iteration

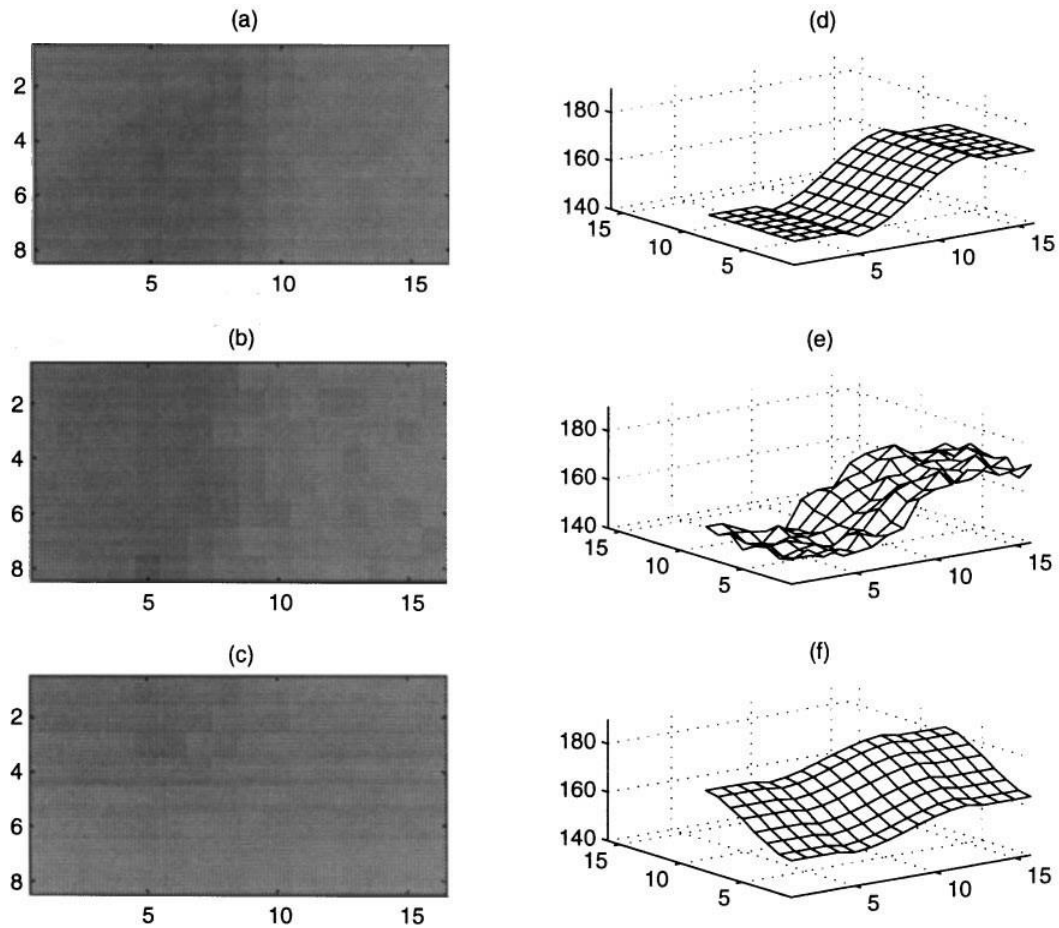


Fig 3.5 Block artifact minimization by zero masking technique (a) And (d) for the noise-free case (b) and (e) having variance of $\sigma^2=5$ (c) and (f) functional case

3.6.) Simulation Outcomes

The algorithm recommended here has been carried out in Matlab R2010a and has been finished. Figure 3.1 is the block formation image. Figure 3.2 is the input image of original scene. Zero-Masking algorithm has been tested on these figures. The algorithm tested on DCT coefficients with the one and five repetitions. At the early match of repetition blocking artifacts was visible in remarkably tone. With the five repetitions blocks cut out with very good visual quality. Fig 3.3 presents pixel gray value and 3D structure. Fig. 3.4 left portion of image with

the technique succeeding one repetition. Blocking Artifact suppression by applying Zero-Masking with .26 bits per pixel is calculated. Figure 3.4 presents the concluding product image succeeding suppressing block with the help of technique. The procedure is also tested on peppers image, with same number of repetitions. Figure 3.6 presents the left with original image and right with compressed succeeding repetition. Figure 3.7 left image is having one repetition and right portion is the five repetition of technique with minor blocking and that is the resultant image for peppers. Simulation outcomes present that both subjective viewpoint and objective image virtue are remarkably renovated.



Fig 3.6: Peppers left with original image and right with one iteration of proposed method.



Fig 3.7: image showing left with three iteration and right with five iteration the output image.

3.7. Conclusion

Zero-Masking technique is an uprising for the area of suppressing block Artifact, with its approach of horizontal and vertical direction choice. It extracts deeply blocked space from the image. It supports in suppressing block artifacts with less number of repetition of technique. This technique is vigorous to variation in illumination, noise and less variation in bits per pixel. It is potent towards the alteration of the image.

Chapter 4

Suppression of Blocking Artifacts by Segmentation



- *GENERAL CONCEPTION*
- *PREFACE*
- *RECOMMENDED APPROACH*
- *ALGORITHM FOR RECOMMEND METHOD*
- *EXECUTION ESTIMATION*
- *SIMULATION USING MATLAB*
- *OUTCOMES & ARGUMENT*
- *CLOSURE*

4.1. General Conception

Image segmentation is the mechanism of subdividing an image into its constituent components i.e. homogeneous and meaningful regions according to their similar group of characteristics or peculiarities. Segmentation algorithms are dependent on distinct criteria of an image such as gray level, colour, texture, depth, and motion. The image segmentation mechanism may be expressed as the basic and very essential mark in digital image processing and computer vision utilizations. With the rising requirement for compressed data picture and better visual quality, the requirement for correct segmentation of image has also developed durable and as an outcome, lot of image segmentation approaches and algorithms have been refined over the last few decades.

The outcome of image segmentation is a group of zones that generally mask the full image, or a group of curves that are extracted from the image.

4.2. Preface

In image processing, segmentation is the mechanism of identifying objects in a picture. We all know that every image is a set of pixels and partitioning those pixels on the basis of their similar characteristics they have is called segmentation. Partitioning an image into sub parts on the basis of a few identical characteristics like colour, intensity and texture is called image segmentation.

The target of segmentation is to diversify the portrayal of an image into being extra relevant and simpler to clear out. Image segmentation is generally tested to detect articles and boundaries that are lines, trajectories, etc. in images.

In image segmentation, an image is split into few zones and in that zone every pixel is identical with respect to a few of the properties like colour, intensity / texture. Adjoining zones

are much distinct with respect to the similar essentials. Segmentation of image is an essential technique for image processing .It is tested to evaluate the image innermost. Image segmentation is tested to independent an image into few *relevant* sections.

Segmentation assigns to the mechanism of dividing an image or picture into different numerous segments that having pixel groups. Segmentation may be completed by recognizing edges mark or boundary in the picture. When we recognize the marks in a picture then based on resemblance between any two marks.

We can manufacture them into independent zones. We can separate the image segmentation techniques into two different classes.

Algorithm for the segmentation of image are generated depend on two elemental properties of intensity values:

- Discontinuity based segmentation
- Similarity based segmentation

4.2.1. Discontinuity based approach

The segregation is done depend on few abrupt adjustment in gray level intensity of the picture. The spotlight of this area on segmentation approaches that are based on detecting sharp changes in the intensity. There are three types of image features in which we are obsessed are

- ✓ Isolated points
- ✓ Lines
- ✓ Edges

Edge pixels are those pixels at which intensity of an image function alters suddenly. Edge segments *are group of connected edge pixel*. Edge detectors are local image processing method designed to detect edge pixels.

The frequent way to look for discontinuity, is mask, through the image:

- Hidden mark identification
- Line identification
- Identification of edge

4.2.2. *Similarity based approach*

Segmentation is compassed depend on organizing of pixels depend on few faces.

- Thresholding
- Region growing
- Region Splitting and Merging
- Clustering

Because of Discontinuity in blocks, discontinuity based approach will be used in the proposed method. For the blocking artefact removal, edge detection based discontinuity segmentation is used.

4.3. Recommended Approach

As mentioned, segmentation of image or graphics sections is proficient. Furthermore, the graphic sections are also mentioned to be segmented into zones, each of which involves a

background of homogeneous colour. In this recommended mechanism it is expressed how blocking artifacts are suppressed in illustrated zones.

Let us consider a digital image defined over pixel grid. In the following steps, only consider gray value of the images (range 0 to 255). In exchange for the wipe out the blocking artifacts from a illustrated zone, initially we mark the pixels in the zone as edge or non-edge. This may be proficient by several classic edge detection algorithms. Further, we analyze the pixels that lie on the 8×8 brick boundary recycled in JPEG compression. If a preceding awareness about the brick boundary is not accessible, it may be resolved by a Maximum A Posteriori (*MAP*) like evaluator. For every non edge pixel on the brick boundary, a Sigma Filter is tested to polished out the blocking artifacts. Sigma Filter is an edge preserving smoothing filter. Its result is a moderate over the pixels with a limited window. In computation for the moderate, the pixels whose unconditional brightness variation with the present pixel outstrip a threshold value are eliminated.

4.3.1. Edge Detection

Sampling and other image additional deficiency yield edges that are blurred with the degree of blurring determined by factors like quality of image acquisition system, sampling rate, illumination condition under which the image is required.

Edges are closely shaped as having *ramp* profile. The slope of the ramp is inversely proportional to the degree of blurring in edges. The thickness of the edge is fixed by length of ramp. This length is determined by the slope which in turn is fixed by degree of blurring.

It makes feel that Blurred edges tend to be thick and sharp edges tend to be thin. This process commit the sum of products of the coefficients with gray levels enclosed in the space encircled by the mask. The reply of the mask at any point in the image as:

w_1	w_2	w_3
w_4	w_5	w_6
w_7	w_8	w_9

Fig.4.1 General 3x3 mask

Given by

$$R = \sum_{i=1}^9 w_i z_i = w_1 z_1 + w_2 z_2 + \dots + w_9 z_9 \quad (4.1)$$

-1	-2	-1
0	0	0
1	2	1

-1	0	1
-2	0	2
-1	0	1

Fig 4.2. Mask for sobel operator left for horizontal and right for vertical



Fig 4.3. Left is deblocked image and right one having Edge detection result of input image with .312 bpp

4.4. Algorithm for Recommend Method

1. Select an image
2. Compute the gradient of an image with

$$N(x,y) = \sum_{k=-1}^1 \sum_{k=-1}^1 K(j,k)p(x-j,y-k)$$

3. Threshold it to obtain a binary image
4. Identify the pixel in zone as edge or non-edge,
5. Confirm that pixel lie on 8x8 block boundary
6. If non edge pixel lies on boundary, Sigma filter used
7. For average calculation, pixel whose unconditional intensity difference with present pixel exceeds a Threshold value, those pixel will be excluded
8. End

4.5. Execution estimation

The two objective likewise visual execution estimation has been a necessary factor of picture virtue estimation mechanism. Here, the reproduction outcome picture virtue is confirmed in phrase of (PSNR) Peak Signal –to- Noise Ratio, Mean Structure Similarity Index based on human visual perception (MSSIM), Block Based Measure (BBM), and Human visual System (HVS).

PSNR for Compression measurement

The peak signal-to-noise ratio is computed inserted with the mention and refined picture. As the PSNR higher, the recreated picture get the improved virtue of picture. PSNR may be computed by testing the consecutive equation:

$$PSNR = 10 \log_{10} \left(\frac{R^2}{MSE} \right) \quad (4.2)$$

Where,

R= max. intensity value in the input picture data.

MSSIM as virtue Determination

For picture virtue rating, it is practical to use the MSSIM indicator regionally rather than all- around. The regional data are calculated within a regional $w \times w$ kernel, which shifts pixel-by-pixel over the full picture. At each mark, the regional data and MSSIM indicator is computed within the regional window. In system, an individual global virtue determination of the full picture is needed. (MSSIM) indicator to estimate the global picture virtue is calculated as-

$$MSSIM (A, B) = \frac{1}{M} \sum_{i=1}^M SSIM(a_i, b_i) \quad (4.3)$$

Where

A and B = Initial and restored pictures correspondingly

a_i and b_i = image contents at the i^{th} regional kernel

M is the no. of regional window of the image

SSIM (a, b) is defined as

$$SSIM (a, b) = \frac{(2\mu_a\mu_b + C_1)(2\sigma_{ab} + C_2)}{(\mu_a^2 + \mu_b^2 + C_1)(\sigma_a^2 + \sigma_b^2 + C_2)} \quad (4.4)$$

μ_a and μ_b = Mean Intensity

σ_a and σ_b = standard deviation

C_1 and $C_2 = \text{Constant}$

As two similar pictures, (MSSIM) is equivalent to one. This, being a detached approach to fix emotive picture virtue has been practiced in current estimation.

BBM as Quality Measure

This indicator is practiced at present to allot the portion of blocking artifact at block boundaries.

Obsessed a picture

$$f = \left\{ \begin{array}{c} b_{i,j}^{0,0} b_{i,j}^{0,1} \dots b_{i,j}^{0,tb-1} \\ b_{i,j}^{1,0} b_{i,j}^{1,1} \dots b_{i,j}^{1,tb-1} \\ \vdots \\ b_{i,j}^{tb-1,0} b_{i,j}^{tb-1,1} \dots b_{i,j}^{tb-1,tb-1} \end{array} \right\}$$

Where-

$b_{i,j} = (i,j)^{th}$ pixel intensity value

$(p,q) = (p,q)^{th}$ block,

t_b = total no. of blocks in image

For the vertical boundaries between block of 8×8 pixel, it is calculated as pursues:

$$BBM_v = \frac{1}{(tb-1)^2} \sum_{p=0}^{tb-2} \sum_{q=0}^{tb-2} \|b_{7,j}^{p,q} - b_{0,j}^{p,q+1}\|, \forall j \in [0,7] \quad (4.5)$$

Correspondingly, BBM for horizontal can be achieved as:

$$BBM_H = \frac{1}{(tb-1)^2} \sum_{p=0}^{tb-2} \sum_{q=0}^{tb-2} \|b_{i,7}^{p,q} - b_{i,0}^{p,q+1}\|, \forall i \in [0,7] \quad (4.6)$$

Image	Bit rate (bpp)	PSNR for various window space		
		3 × 3	5 × 5	7 × 7
Lena	0.312	32.18	34.12	28.98
foreman	0.265	28.17	29.14	24.46
Peppers	0.142	31.43	23.67	31.42
Hall	0.196	29.52	31.28	29.23

Table 4.1 PSNR observation for distinct window space of sigma filter, recommended method practiced with distinct JPEG compressed pictures

The detached estimation of decompressed image is represented as:

Table 4.2: Achievement study of JPEG, Zero-Masking and Proposed method

Image	Bit rate	JPEG	Zero masking	proposed
Lena	0.31	1.59	2.32	1.47
	0.29	1.09	1.74	.92
	0.15	3.76	5.15	4.39
Hall	0.29	1.56	2.13	2.01
	0.24	1.12	2.13	1.42
	0.35	1.98	2.18	1.07
Pepper	0.28	.76	1.03	.43
	0.20	3.28	1.98	.90
	0.30	1.32	2.87	1.43

4.6. Simulation using MATLAB

The algorithm proposed here has been implemented in Matlab R2010a and has been executed. Fig 4.7 and fig 4.8 are the left and right portion of the input images of original scene. JPEG implementation has been applied on these figure .then with the Sobel operator edge detector edge has been detected. The fig 4.9 shows. Those edges having block artefact removed by segmentation algorithm. The inconsistent points i.e. outliers, which don't fit to the model parameters are removed by it and the algorithm take only consistent points i.e. inliers which fit to the model parameters. Fig 4.10. Fig 4.11 shows the final output image after reconstruction and suppressed block artifacts.

Image	Bitrate (bpp)	JPEG	ZERO MASKING	Proposed method
Lena	0.312	32.18	30.28	31.12
Foreman	0.265	28.17	29.43	27.96
Peppers	0.152	31.43	34.82	33.56
Hall	0.196	29.52	32.26	29.49

Table 4.3 PSNR observation for distinct post -processing methods

4.7. Outcomes & Argument

In the recommended method, the standard examine image is the input image .The pictures has exclusive aspect is, invariant to focus, illumination from the different angles. Here, the standard input pictures are shown in Fig.4.8 and Fig.4.9. The input pictures don't having any type of brightness change and pixel change. The dirt certainty picture has been developed practicing Auto-stich operating system. The pictures are refined over JPEG implementation and

segmentation techniques independently in an alongside procedure. The feedback of techniques is presented below:



Fig.4.4 Visual virtue observation of image compressed at 0.298 bpp with distinct techniques.

Left is input Lena image and Right is reconstructed Lena image

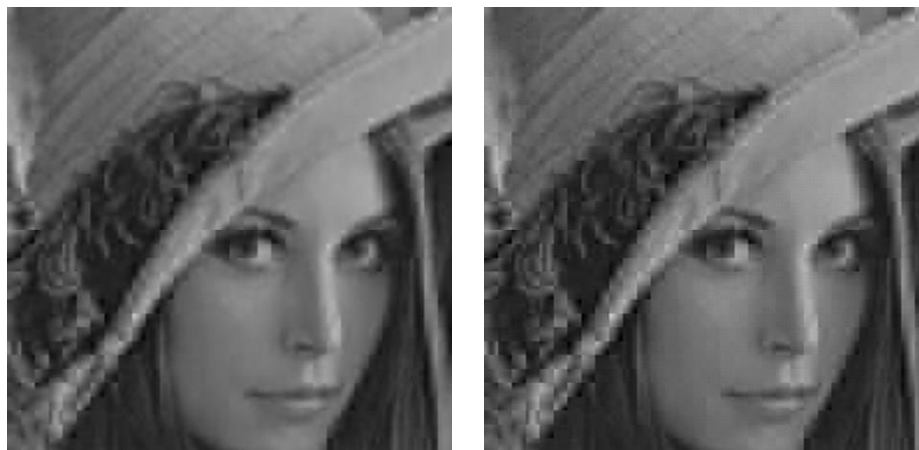


Fig.4.5 Fixed Lena image Left Image processed by Zero Masking Method with one iteration and Right Image processed by Zero Masking Method with five iteration.

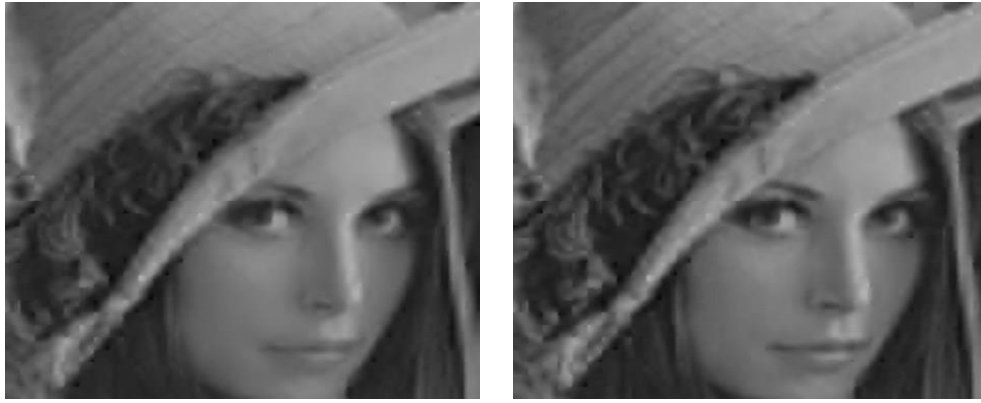


Fig.4.6 Visual virtue observation of input image compressed with 0.298 bpp Left one is JPEG compressed image, and right is reconstructed image,

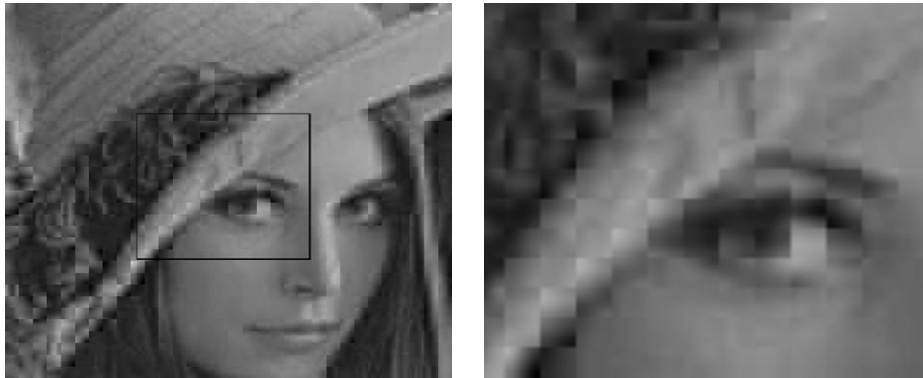


Fig.4.7 Processed Lena image in left with Highlight of Visible blocking artifact in reconstructed image, and in right shooted up fraction nearby eye space having block artefact.



Fig.4 Shooted up fraction nearby eye space succeeding minimisation of block artifacts.

Part under eye resides to the polished zones and the above it is the non- polished zones. For eyebrow zone edge preserving polishing filter (sigma filter) effects and for polished zone blocking artifacts diminished by technique.



Fig. 4.9 Left is original Hall Image, and right is JPEG compressed hall image



Fig. 4.10 Subjective Quality Comparison of Hall Image Left having Removal of block artefact with one iteration of proposed method and right having block artefact removal with three iteration of proposed method.

4.8. Closure

In this unit, an innovative approach to minimise of blocking artifact technique for segmented image has been recommended. The prescribed image is encountered by Sobel operator edge detector for the block recognition. Edge represents the boundary between zones. Edge detection is variant towards lighting condition and density of edges. It is also robust towards noisy environment. Sobel operator edge detector calculates gradient of image intensity at each point. After-all, this is having the attainment of brightness constant and very good calculation quickness. So, the outcome of this useful detector provides hike to a scenic picture, which bears entire the effects of segmentation. The execution estimation of recommended technique is completed in titles of PSNR, MSSIM and BBM .The recommended technique presents preferable results with less calculation time as compared to Zero-Masking Technique.

Chapter 5

Conclusion



➤ *CONSEQUENCES*

➤ *ADVANCEMENT FOR FUTURE EFFORT*

This unit has brightening position on the development and obstacles of entire the techniques applied for suppression of blocking artifact with compressed image. The extension of impending research work in this sphere are also discussed.

5.1. Consequences

JPEG and MPEG is the most frequently used compression standard for image and video compression respectively. The objective for the compression of image is to minimise the depot and transfer prices although protecting image visual virtue. we shorten information and encounter undesirable artifact so the subjective quality of the image degraded. To improve the visual virtue of image, individually handle effective suppression of blocking artefact in compressed image .BDCT coding become frequently followed in picture shorten classic for diminishing inter-pixel repetition, like JPEG. This JPEG implementation has three marks:

- ✓ DCT,
- ✓ Quantization,
- ✓ Transform image coding.

It is used for the compression of an image to decrease the data transmission cost and time.in this chapter, it is widely used for the compression of pixel values, which are nothing but the concern bits of a block. Concern bits are operated for getting satisfactory subjective quality of image having compression on that image. JPEG compression is dynamic, smooth and constant to any revolution but it can't shaft the images which go through moving.MPEG is choice of compression standard for continuous moving images. JPEG compression beaten this obstacle of compression since it is robust to noise, minor changes in bits and also towards the size of image and orientation constant of the image.

Zero Masking Technique extracts highly distinctive features from the set of images. It helps in removing of block artifact with very good subjective quality for the highly compressed images. But the Zero –Masking algorithm was found to perform much better for the removal of blocks but also it holds more time for execution and not smooth to execute. Hence to supplement the complimentary features.

A new compression based annoying artifact reduction technique using image segmentation has been recommended and implemented based on a robust algorithm which guards the effect of circumvolution, illumination, noise variation and other petty variation. The input image made compressed with the compression standard to select the best appearance and low bit data, the DCT procedure is completed whereby Block-Based Discrete cosine Transformation (BDCT) practicing the superlative extraction guideline for the close likewise elements. Power and aspect of the above passed-down techniques are inspected by means standard images. The wide- ranging image set-up through segmentation procedure satisfied the interdependent factors and upgrade the accepted details for compressing images.

Zero –Masking algorithm has the excellent property of removing block artifact along with Satisfying range and rotational constant effect, whereas segmentation is more effective algorithm for natural images. But, it cannot cope up with variation of images or frame of video. Therefore, the respond image verifies admirable in subjective matter as compared to the JPEG standard algorithms, in phrase of (PSNR). Visual virtue inspects by (BBM) Block boundary measure, MSSIM (Mean structure similarity index based on human perception), Human Visual System (HVS).

5.2. Advancement for Future Effort

The willing attempt was based on the implementation and the computable clarification of the above specified techniques of removing block artifact in image compression. Also an advance and design has been proposed to increase the performance of the top on technique to produce the better visual quality of images by the segmentation of image and by zero masking technique. The trial judgment images used for the present task were the standard images, it can be spread for any type of images as well. Various algorithms can be in addition to improve at the algorithmic match rather than at the plane of implementation to set-up the added and complimentary presentation of the other algorithms, and hence the execution time as well the operational length can be highly reduced with the better subjective quality in highly compressed images.

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