Development of Efficient Image Compression using Iterative DCT Processing

Priyanka Agarwal[1], Prof. Priyanka Saxena[2]

[1]M.Tech Scholar, [2]Research Guide

Department of Computer Science & Engineering, SIRT-E, Bhopal

Abstract*–Demand of storage for multimedia content is increases day by day. The advancement in the technology of cameras and imaging devices producing large data like FHD, FHD+ and 4K etc. Such large data need large storage to keep it accessible any time. Such large files are a challenge to process and store on media like HDD, SSD, Flash drive and Cards. To store more data on same storage capacity there is need of compression of data, which reduces the data size and keep the information as it is.So storage providers and service providers need to work out on efficient compression techniques which significantly reduce the size of images without compromising its quality. This work proposed aimage compression technique which reduces the file size of the image with maintaining its structure. In this work we have worked on iterative DCT domain masking scheme to reduce the file size of the image. The simulation result shows the merit over previous work.

Keywords- Compression, Lossy, DCT Masking, Iterative, Matrix, etc.

I. INTRODUCTION

Pictures have been with us since the dawn of the time. However, the way the pictures have been presented and displayed has changed significantly. In old age, pictures are represented and displayed in a physical way such as painting in cave walls or etching in stones. In recent times, pictures are dealt electronically. Interestingly, the representation used for storage and transmission is quite different from its display. For example, in traditional broadcast television, where this representation which is transmitted is not directly related to the intensities of red, green and blue electron guns in a television set.

The possibilities of image representation increases dramatically by storing images in digital form. There can be numerous ways an image can be stored in any representation, provided that there should be algorithms to convert back to a form usable for display. This process of changing the representation of an image is called image coding. If the image representation consumes less storage space than the original, it is called image compression.

The encoder performs compression and decoder performs decompression. The encoder consists of mapper, quantizer and symbol encoder. Usually the mapper transforms an image into an invisible format designed to reduce spatial and temporal (in video sequences) redundancy. Generally, this operation is reversible and may or may not reduce the amount of data needed to represent the image. In video applications, the mapper uses previous and future frames to facilitate removal of temporal redundancy.

The quantizer reduces the accuracy of the output of mapper according to the fidelity criterion. This operation is irreversible and targets to remove irrelevant in- formation from the image. When lossless compression is needed, quantizer must be removed. The final stage of the encoding process is the symbol encoder, which generates a fixed or variable-length code to represent the quantizer output. Usually the shortest code words are assigned to the most frequently occurring quantizer output values to minimize coding redundancy. This operation is reversible. These three operations lead to removal or decrease of all three redundancies from the input image.

Lossless versus Lossy compression: In lossless compression schemes, the reconstructed image, after compression, is numerically identical to the original image. However lossless compression can only achieve a modest amount of compression. Lossless compression is preferred for archival purposes and often medical imaging, technical drawings, clip art or comics. This is because lossy compression methods, especially when used at low bit rates, introduce compression artifacts. An image reconstructed following lossy compression contains degradation relative to the original. Often this is because the compression scheme completely discards redundant information. However, lossy schemes are capable of achieving much higher compression. Lossy methods are especially suitable for natural images such as photos in applications where minor (sometimes imperceptible) loss of fidelity is acceptable to achieve a substantial reduction in bit rate. The lossy compression that produces imperceptible differences can be called visually lossless.

II. IMAGE COMPRESSION MODEL

Predictive versus Transform coding: In predictive coding, information already sent or available is used to predict future values, and the difference is coded. Since this is done in the image or spatial domain, it is relatively simple to implement and is readily adapted to local image characteristics. Differential Pulse Code Modulation

(DPCM) is one particular example of predictive coding. Transform coding, on the other hand, first transforms the image from its spatial domain representation to a different type of representation using some well-known transform and then codes the transformed values (coefficients). This method provides greater data compression compared to predictive methods, although at the expense of greater computational requirements. Image compression basic model shown here in figure 2.1 and 2.2 consists of a Transformer, quantizer and encoder.

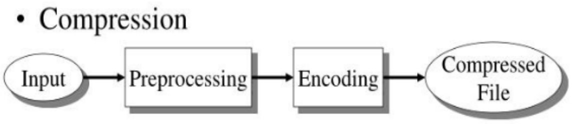

Figure 2.1 Image Compression Model

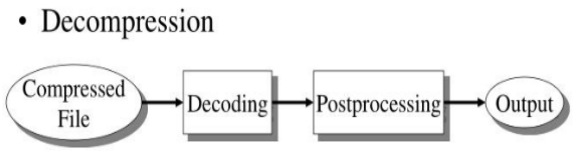

Figure 2.2 Image Decompression Model.

1. Transformer:

It transforms the input data into a format to reduce interpixel redundancies in the input image. Transform coding techniques use a reversible, linear mathematical transform to map the pixel values onto a set of coefficients, which are then quantized and encoded. The key factor behind the success of transform-based coding schemes is that many of the resulting coefficients for most natural images have small magnitudes and can be quantized without causing significant distortion in the decoded image. For compression purpose, the higher the capability. Of compressing information in fewer coefficients, the better the transform; for that reason, the Discrete Cosine Transform (DCT) and Discrete Wavelet Transform(DWT) have become the most widely used transform coding techniques.

(a) DCT:

DCT is an orthogonal transform, the Discrete Cosine Transform (DCT) attempts to decorrelate the image data. After decorrelation each transform coefficient can be encoded independently without losing compression efficiency.

The DCT transforms a signal from a spatial representation into a frequency representation. The DCT represent an image as a sum of sinusoids of varying magnitudes and frequencies. DCT has the property that, for a typical image most of the visually significant information about an image is concentrated in just few coefficients of DCT. After the computation of DCT coefficients, they are normalized according to a quantization table with different scales provided by the JPEG standard computed by psycho visual evidence. Selection of quantization table affects the entropy and compression ratio. The value of quantization is inversely proportional to quality of reconstructed image, better mean square error and better compression ratio.

In a lossy compression technique, during a step called Quantization, the less important frequencies are discarded, and then the most important frequencies that remain are used to retrieve the image in decomposition process. After quantization, quantized coefficients are rearranged in a zigzag order for further compressed by an efficient lossy coding algorithm.

(b) DWT:

Wavelets are a mathematical tool for changing the coordinate system in which we represent the signal to another domain that is best suited for compression. Wavelet based coding is more robust under transmission and decoding errors. Due to their inherent multiresolution nature, they are suitable for applications where scalability and tolerable degradation are important.

Wavelets are tool for decomposing signals such as images, into a hierarchy of increasing resolutions. The more resolution layers, the more detailed features of the image are shown. They are localized waves that drop to zero. They come from iteration of filters together with rescaling. Wavelet produces a natural multi resolution of every image, including the all-important edges. The output from the low pass channel is useful compression. Wavelet has an unconditional basis as a result the size of the wavelet coefficients drop off rapidly. The wavelet expansion coefficients represent a local component thereby making it easier to interpret. Wavelets are adjustable and hence can be designed to suit the individual applications. Its generation and calculation of DWT is well suited to the digital computer. They are only multiplications and additions in the calculations of wavelets, which are basic to a digital computer.

2. Quantizer:

It reduces the accuracy of the transformer's output in accordance with some pre-established fidelity criterion. Reduces the psychovisual redundancies of the input image. This operation is not reversible and must be omitted if lossless compression is desired. The quantization stage is at the core of any lossy image encoding algorithm. Quantization at the encoder side, means partitioning of the input data range into a smaller set of values. There are two main types of quantizers: scalar quantizers and vector quantizers. A scalar quantizer partitions the domain of input values into a smaller number of intervals. If the output intervals are equally spaced, which is the simplest way to do it, the process is called uniform scalar quantization; otherwise, for reasons usually related to minimization of total distortion, it is called non uniform scalar quantization. One of the most popular non uniform quantizers is the Lloyd Max quantizer. Vector quantization (VQ) techniques extend the basic principles of scalar quantization to multiple dimensions.

3. Symbol (entropy) encoder:

It creates a fixed or variable-length code to represent the quantizer's output and maps the output in accordance with the code. In most cases, a variable-length code is used. An entropy encoder compresses the compressed values obtained by the quantizer to provide more efficient compression. Most important types of entropy encoders used in lossy image compression techniques are arithmetic encoder, huffman encoder and run-length encoder.

III. PROPOSED METHODOLOGY

Proposed work is in light of productive compression strategy utilizing DCT Coefficient Matrix. The effective variation of JPEG comprises of two sections: the encoder, which changes over a RGB image into a JPEG stream, and the decoder, which changes over the JPEG stream once again into a RGB image. The standard does not determine how this stream is organized in a file. This is liable to the file format's detail, JPEG File Interchange Format (JFIF) being a standout amongst the most well known ones. So as to pack an image, different advances are executed, which depends on proficient compression. Figure 3.1 demonstrates a diagram of all associated with flow chart of proposed image compression technique.

Algorithm:

Step: 1 Start

Step: 2 Browse image to compress.

Step: 3 Calculate File Size.

Step: 4 Convert image data into UINT 8

Step: 5 Initialize discrete cosine Matrix.

Step: 6 Create Equivalent Mask Matrix.

Step: 7 iteratively Process I/P image into Matrix.

Step: 8 Process Previous stage o/p with equivalent mask matrix.

Step: 9 Inversed Processed mask with get Cosine domain.

Step: 10 Convert double image into UINT8.

Step: 11 Calculate size of Image.

Step: 12 Calculate BPP & PSNR.

Step: 13 Compare & Display Results.

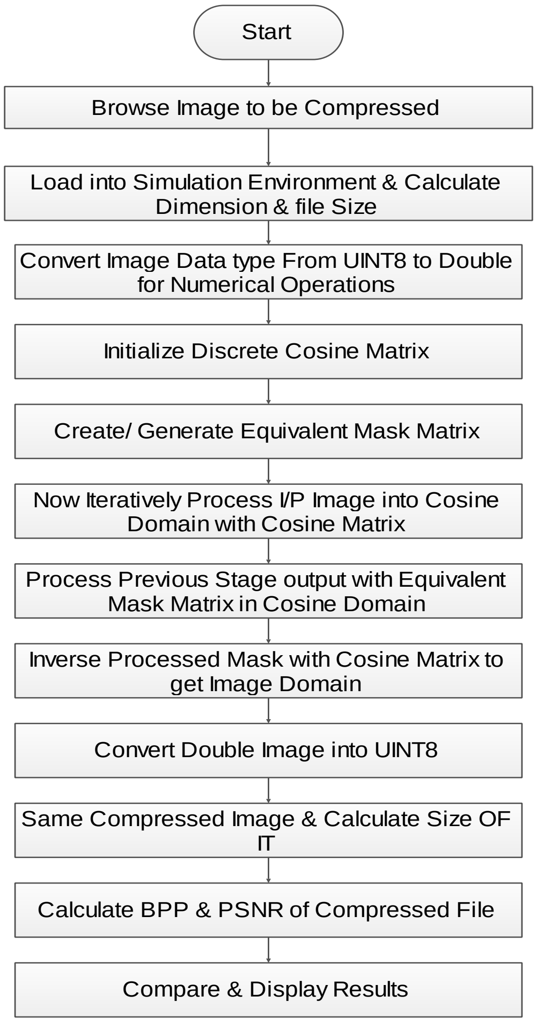

Fig. 3.1 Flow chart proposed Image Compression method.

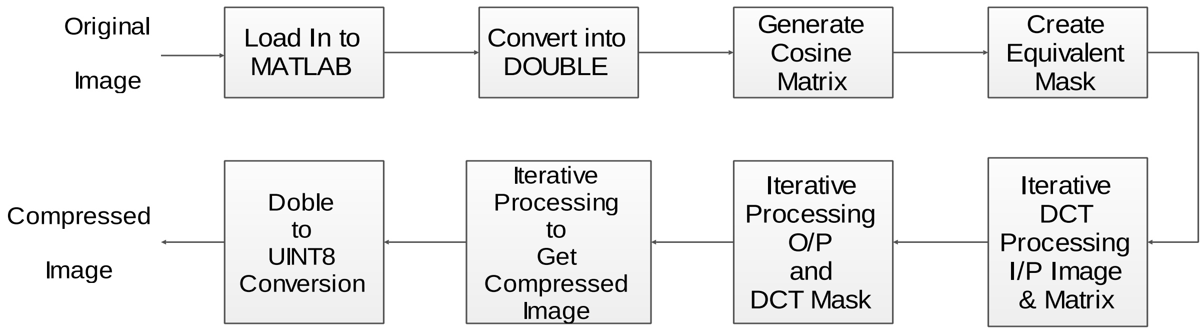

Fig. 3.2 Block Diagram of Proposed Image Compression.

Select the test image which is to be pack utilizing capacity. Burden the image into paired matrix or Matlab Condition. Calculate file Estimate in KB. Furthermore, convert file in to type twofold. Presently Apply square handling on images utilizing DCT Matrix. Characterize Veil Matrix of and square procedure on past stage yield. 9 Currently reuse DCT task to get yield Image Compacted image and calculate Size of the File in KB, with Compression proportion and PSNR. Square Graph of proposed work has given in figure 3.2. Also, test result of proposed work has given ahead. Result of proposed work demonstrates the execution of the entire framework on specific grants.

DCT is an extraordinary type of Fourier transform which breaks down a discrete genuine esteemed capacity f:M^W into an aggregate of cosine elements of various frequencies. At the point when the capacity's domain comprises of N components, the re-structure after re-examining, the image is part in squares of pixels and transformed into frequency space. This is performed utilizing discrete cosine transform (DCT, DCT's lD-definition can be stretched out to two measurements by applying 1D DCT to segments and columns after one another.

It very well may be seen that the coefficient's total qualities decline as the frequencies that they speak to increment. This is brought about by the image's general smoothness, which is one condition for the JPEG codec to be proficient.

Another perception respects the coefficients' signs. While the signs are constant in the zero-frequency image (since this is the down-scaled information image), every other frequency don't demonstrate this property. There are little associated districts with a similar sign, anyway all in all it changes in all respects much of the time over the image.

Figure 3.2 delineated the square outline of proposed work. DCT the essential area of proposed work are as per the following Information Image, Square Handling 1, and Square Preparing 1 and square preparing 2 coefficient matrixes. Square preparing as tallied is associated with another invert circle. The part id s hardware to assess and calculate. Image measure files figuring. Calculate CR Image compression a sPSNR.

IV. SIMULATION RESULTS

Image Transform strategies utilizing symmetrical part works are regularly utilized in image compression. A standout amongst the most generally realized image transform techniques is DCT, which is utilized in JPEG compression standard. The figuring gadgets, for example, individual digital associates, digital cameras and cell phones require a great deal of image transmission and preparing. In spite of the fact that different productive compression procedures have been accounted for, the wide scope of sight and sound applications requests for further improvement in compression quality.

The implementation of proposed work has done on the MATLAB. the outcome of proposed work has given in figure 4.1 Original Image. Table 1 Comparison of Compression Ratio.

(a) (BPP: 0.181, PSNR: 27.19)

(b)(BPP: 0.152, PSNR: 40.63)

Fig. 4.1 Compression Results (a) Previous Method [1] (b) Proposed Method (Our)

Two dimensional image transforms render the image information in the structure that is effectively compressible. DCT based JPEG and DWT based JPEG2000 are outstanding existing models. Research still keeps on getting more compression absent much corruption in the execution. Despite the fact that wavelets are prepared to do more Adaptable space-frequency goals tradeoffs than DCT, DCT is still generally utilized in numerous handy applications in light of its compression execution and computational points of interest. a changed square DCT based compression plot joining the possibility of self-closeness obtained from Irrelative procedure is proposed.

Table 1: Compression Result Comparison

Technique	***Previous [1]***	***Proposed (Our)***
BPP	0.181	0.152
PSNR (dB)	27.19 dB	40.63 dB

Table 4.1 has given comparison study of previous work with proposed work. Graphical representation of Table 4.1 has given in figure 4.2 and figure 4.3.

Graphical representation of proposed work has given in figure 4.2.In fig. 4.3 show the graphical representation of BPP comparison of previous work and proposed work. It is seen that there is less decrease in bit-rates when contrasted with Past strategies image. Likewise, as the bit-rate dips under bpp, the PSNR execution is practically consistent for every one of the estimations of limit and scale factors.

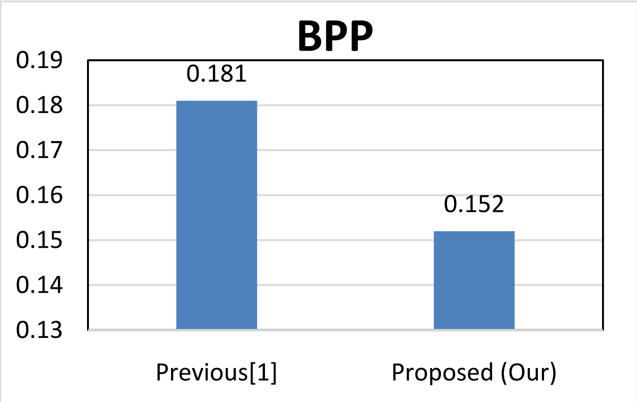

Fig. 4.2 BPP Comparison.

Graphical representation of PSNR value has given in figure 4.2. In this figure shows the graphical comparison of PSNR estimation of Past and proposed works. the PSNR execution is practically consistent for every one of the estimations of limit and scale factors. All things considered, the decrease in decompressed image quality is to be made a decision from the other execution parameters:

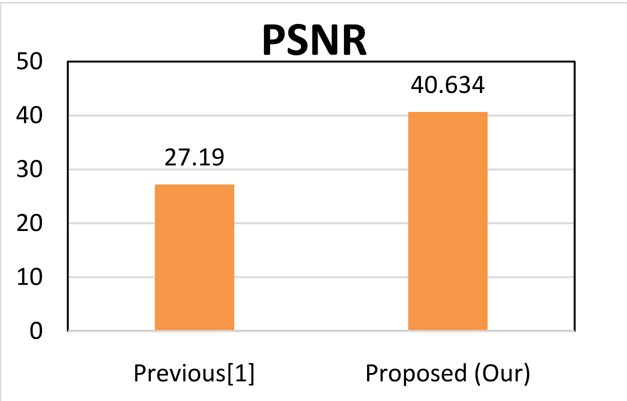

Fig. 4.3 PSNR Comparison

Proposed compression algorithm is tested on other color images also which are shown below. The values of PSNR and BPP is improved and visual quality is maintained.

In Table 2 original and compressed images are shown with respective values of BPP and PSNR.

Table 2: Compression Result on different color images

#	Original	Compressed
1	 File Size: 8150.278 KBs	 File Size : 1515.254 KBs PSNR : 38.345 dB BPP : 0.119
2	 File Size: 4211.896 KBs	 File Size : 1444.442 KBs PSNR : 39.487 dB BPP : 0.113
3	 File Size: 4872.226 KBs	 File Size : 1704.012 KBs PSNR : 38.603 dB BPP : 0.133

V. CONCLUSION AND FUTURE SCOPES

In the work image compression techniques utilizing DCT are executed in efficient compression domain. With the advancement of development and the passageway into the Digital Period, the world has wound up amidst a colossal proportion of data. Managing such colossal measure of information can frequently introduce challenges. Digital data must be put away and recovered gainfully in order to put it to down to earth use an efficient Compression using DCT Coefficient Matrix. There are other image sources that produce a lot higher information rates. Limit and transmission of such information require colossal farthest point and exchange speed, which could be expensive. Image data weight framework, stressed over the decline of the amount of bits required to store or transmit image with no calculable loss of data. Regardless of whether Discrete Cosine Transform is a broadly adjusted and vigorous strategy utilized for compression of digital image as it can convey by far most of the data in most humble number of pixels appeared differently in relation to other technique, the DCT Transform gave better result to the degree properties like RMS mistake, image power and execution time is concerned.

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