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# Fractal Color Image Compression using Wavelets and Inter-Color Correlation

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*Abstract:* **Fractal image compression (FIC) is a novel technique which promises higher compression efficiency for large scale images. FIC is a lossy compression method for digital images based on fractals. The method is best suited for natural images relying on the fact that parts of an image resemble other parts of the same image. The proposed research work aims at development and implementation of various FIC techniques computing Compression Ratio (CR), mean square error (MSE) and Peak Signal to Noise Ratio (PSNR) for the imageries. The FIC also addresses the issue of reducing the encoding time. FIC has been implemented using wavelet and inter color correlation system. Partitioning of the image will be carried out using 16×16 and 32×32 range block. The approach to classify image block more accurately based on the FIC techniques will accelerate fractal encoding process to achieve higher CR while keeping good quality of the reconstructed image and speedup encoding-decoding time.**

***Index Terms* – Multi-level Block Truncation Code (ML-BTC), Bit Map, Peak Signal to Noise Ratio (PSNR), Mean Square Error (MSE), Inter Color Correlation**

## I. INTRODUCTION

Compression is the regular answer for the issue of lessening picture extra room, transmission time and data transmission prerequisites. Effective compression of crude computerized picture is the primary prerequisite for all picture and video applications. Without having a picture compression calculation with a high Compression Ratio (CR), transmission of visual data over basic transmission channels and furthermore stockpiling of them on normal advanced stockpiling media are wasteful. Video compression gauges broaden the picture compression procedures to incorporate strategies for decreasing worldly or outline to-outline redundancies [1]. To put it plainly, a consistently extending number of uses rely upon the effective stockpiling and transmission of pictures. Picture compression is the way toward changing over an info crude advanced picture into a yield double information stream that has a littler size, which upon reconversion, must yield a practically comparable (or accurate) reproduction of information crude computerized picture. The yield paired information stream is whichever a record or a support in memory.

Image compression strategies can be characterized into two gatherings: lossless and lossy methods. In lossless picture compression, the recreated picture after compression is numerically and outwardly indistinguishable from the first picture on a pixel-by-pixel premise. Clearly, lossless compression is unmistakably wanted since no data is undermined. In any case, just a humble measure of CR is conceivable. In various applications, lossless picture compression is the main adequate methods for picture compression. One such application is the recorded of business archives. Another application is the preparing of satellite symbolism, where both the utilization and cost of procuring the picture information makes any misfortune unwanted. One more application is therapeutic imaging, where the loss of data can bargain indicative precision. In this way, the requirement for lossless picture compression is persuaded by the planned application or nature of pictures viable [2, 3]. In lossy picture compression, the reproduced picture after compression contains debasements comparative with the first picture and a lot higher CR can be accomplished when contrasted with lossless compression strategies. All in all, more compression is acquired to the detriment of more corruption. It is to be noticed that these debasements might possibly be outwardly evident. Indeed, the term outwardly lossless has frequently been utilized to describe lossy compression strategies that outcome in no noticeable misfortune under ordinary review conditions [4, 5]. The meaning of outwardly lossless is very abstract and extraordinary alert ought to be taken in its translation. It is possible that a calculation that is outwardly lossless under certain survey conditions, for instance, a 19 inch video screen saw a good ways off of four feet, could bring about unmistakable corruptions under progressively stringent review conditions, for example, a 14x17 inch picture imprinted on film. Excitement applications like the Internet, versatile sight and sound, photojournalism, record imaging, FAX and videoconferencing utilize lossy picture compression where the precision of remade picture can be undermined in return for expanded compression [6].

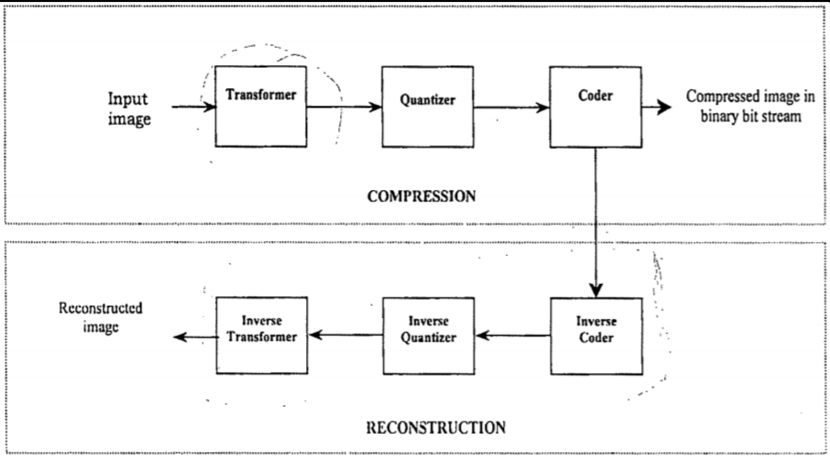


**Figure 1: Elements of data compression and reconstruction model**

Hence while passing on a similar data by various arrangements of the information, there is each probability that a few information are normal between the methods for speaking to the data and can be evacuated as repetitive. The essential thought process behind the information pressure is to scan for such excess and after that to expel them dependably without trading off with the nature of the reproduced data.

The component of an information pressure and remaking model is appeared in Fig. 1. In the primary phase of the picture pressure model the mapper/transformer changes the info information into another configuration/area intended to diminish the between pixel repetition present in the info picture. This task is a reversible one and could conceivably lessen straightforwardly the measure of information required to speak to the first picture. The point behind the portrayal of a picture into a variety of change coefficients is that it causes its to bury pixel redundancies increasingly available for pressure in later phase of the encoding activity [7, 8].

## II. FRACTAL IMAGE COMPRESSION (FIC)

Image compression is an approach to capture the image structure and generalize this structure in coherent and usable form. Compression methods are to eliminate repetitiveness thus producing a more compact code that preserves the essential and accurate information contained in the original image. Because images require large amounts of data storing and transmitting, this data places a significant load on the computer systems and data transmission facilities used. Compression of data reduces the cost of image storage by increasing the effectiveness of storage resources and increases the effective speed of transmission. Since a significant level of redundancy is present in the images and in many cases an image perceptually equivalent but not identical to the original image is acceptable. Decrease in the size of the digital representation is possible by employing suitable image compression techniques. Image compression reduces redundancy in image data to store or transmit only a minimal number of samples from which a good approximation of the original image can be reconstructed in accordance with human visual perception (Courtesy 'Google'). Before using a particular compression technique, it is important to know which category the image compression technique belongs to different applications. There are two broad categories of image compression techniques. The first category consists of methods, which completely preserve the original data. When the compressed image is converted back into its uncompressed form, it is identical with the original image. This kind of technique is called "lossless" compression. For this kind of compression to be effective, there must be some redundancy in the original data [9].

The second category of compression technique consists of methods that only approximate the original data. This category of compression is called "lossy" compression. In general, the less accuracy needed of the resulting image, but achieves greater compression rate. In these two categories of techniques, it is important to know that for any given application, how much degradation in image quality can be tolerated. It is possible to apply objective measures of the quality of the image, i.e. the original image can be compared with the result of compression followed by decompression. The differences can be expressed as a kind of signal to noise ratio, which can be used as a performance measure of the compression technique. Many types of lossy compression and lossless compression have been developed. Among lossy compression the most recent scheme is the fractal image compression (FIC) method. FIC is based on the feature of self-similarity and is a very popular technique due to its high compression ratio, multi resolution properties and fast decompression. FIC techniques exploits redundancy given by partial self-similarity with in an image and encoding procedure is highly computational. It consumes longer time which constrains application to image compression [10].

In FIC, the image to be encoded is divided into a set of image block called range blocks. During the encoding process each range block searches for another part of the same image called a domain block similar to the range block. Because of the similarity matching computation between range and domain blocks is complex, the encoding step of existing FIC method consumes longer time. FIC technique follows the feature of self-similarity which uses Affine transforms set to depict the real image. It also uses iterated function system for developing the recursive iterative function system using College theorem.

## III. PROPOSED METHODOLOGY

Transmission and capacity of crude pictures require enormous amount of circle space. Henceforth, there is an earnest need to decrease the extent of picture before sending or putting away.

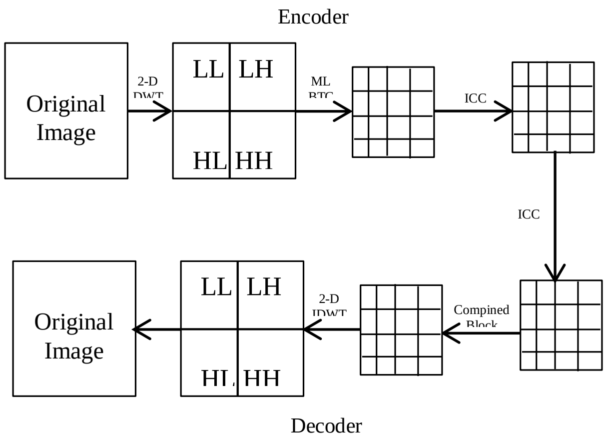


**Figure 2: Proposed Methodology**

The most ideal answer for the issue is to utilize pressure techniques where the pressure of information on advanced pictures are made to diminish insignificance and repetition of the picture information to have the capacity to proficiently store or transmit information. A large portion of the current pressure systems utilized have their negatives and an improved method which is quicker, successful and memory productive can fulfill the prerequisites of the client.

**Inter Color Correlation**

Encoder part of the proposed technique shows that the original image is divided into three parts i.e. R component, G component and B component. Each R, G, B component of the image is divided into non overlapping block of equal size and threshold value for each block size is being calculated.

Threshold value means the average of the maximum value (max) of ‘k × k’ pixels block, minimum value (min) of ‘k × k’ pixels block and $m_1$ is the mean value of ‘k × k’ pixels block. Where k represents block size of the color image. So threshold value is:

$$T = \frac{\max + \min + m_1}{3} \tag{1}$$

Each threshold value is passing through the quantization block. Quantization is the process of mapping a set of input fractional values to a whole number. Suppose the fractional value is less than 0.5, then the quantization is replaced by previous whole number and if the fractional value is greater than 0.5, then the quantization is replaced by next whole number. Each quantization value is passing through the bit map block. Bit map means each block is represented by ‘0’ and ‘1’ bit map. If the Threshold value is less than or equal to the input image value then the pixel value of the image is represent by ‘0’ and if the threshold value is greater than the input image value then the pixel value of the image is represented by ‘1’.

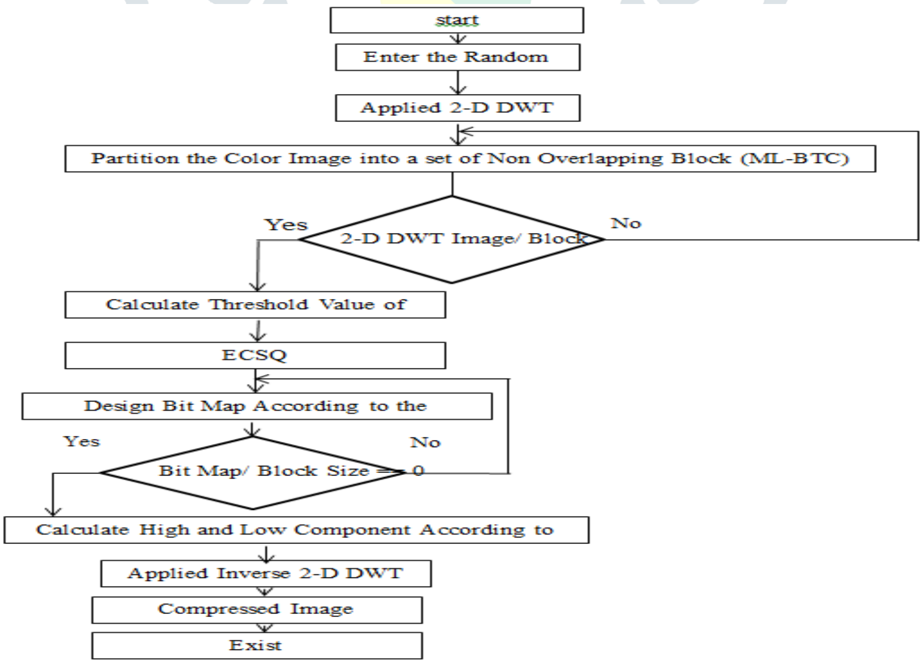


**Figure 3: Flow Chart of Proposed Algorithm**

Bit map is directly connected to the high and low component of the proposed decoder multi-level BTC algorithm. High (H) and low (L) component is directly connected to the bit map, bitmap converted the ‘1’ and ‘0’ pixel value to high and low pixel value and arrange the entire block.

$$L = \frac{1}{q}\sum_{i=1}^{p} W_i \quad W_i \le T \tag{2}$$

$$H = \frac{1}{p}\sum_{i=1}^{p} W_i \quad W_i > T \tag{3}$$

$W_i$ represent the input color image block, q is the number of zeros in the bit plane, p is the number of ones in the bit plane. In the combine block of decoder, the values obtained from the pattern fitting block of individual R, G,B components are combined after that all the individual combined block are merged into a single block . Finally compressed image and all the parameter relative to that image will be obtained.

- **Discrete Wavelet Transform**

The DWT is appropriate to wide band flag that may not be intermittent. In specific the capacity of the wavelet to concentrate on brief time interims for high recurrence parts and long interims for low recurrence segments improves the examination of the sign. In this manner better is the examination, the more precise is the use of the change to information pressure [8]. A. change that is helpful for information pressure ought to have the following properties.

To make a portrayal for the information that makes less relationship among the changed coefficients esteem. This activity is regularly alluded to as decorrelating the information. Actually, the perfect change is one that makes a zero connection between's the coefficients esteems. The Karhunen-Loeve Transform (KLT) is one of such change, which fulfills the reason. Be that as it may, for all intents and purposes the KLT isn't implementable. The pressure of information requires a change with information autonomous networks that lessens the relationship among the change coefficients as much as conceivable instead of wiping out the relationship totally. The motivation behind the decorrelation is to diminish the excess, which empowers the client to quantize every coefficient autonomously,

The change ought to have a portrayal where it is conceivable to quantize various coefficients with various accuracy. That implies the pressure requires a change that focuses the greater part of the vitality of the information signal inside a little number of coefficients.

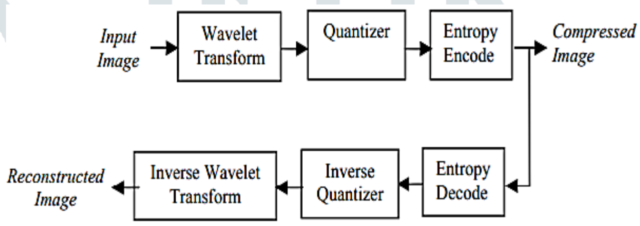


**Figure 4: The structure of the wavelet transform based compression**

The steps of compression algorithm based on DWT are described below:

I. Decompose Choose a wavelet; choose a level N. Compute the wavelet. Decompose the signals at level N.
II. Threshold detail coefficients for each level from 1 to N, a threshold is selected and hard thresholding is applied to the detail coefficients.

## IV. IMAGE QUALITY MEASURES

It is based on the assumption that the digital image is represented as $N_1 \times N_2$ matrix, where $N_1$ and $N_2$ denote the number of rows and columns of the image respectively. Also, $f(i, j)$ and $g(i, j)$ denote pixel values of the original image before compression and degraded image after compression respectively.

Mean Square Error (MSE)

$$= \frac{1}{N_1 N_2}\sum_{j=1}^{N_2}\sum_{i=1}^{N_1}(f(i,j) - g(i,j))^2 \tag{4}$$

$N_1$ = Row Dimension of Image
$N_2$ = Column Dimension of Image
f(i, j) = Original Image
g(i,j) = De-noising Image
Peak Signal to Noise Ratio (PSNR) in dB

$$= 10 \times \log_{10}\left(\frac{M \times N}{MSE}\right) \tag{5}$$

Evidently, smaller MSE and larger PSNR values correspond to lower levels of distortion. Although these metrics are frequently employed, it can be observed that the MSE and PSNR metrics do not always correlate well with image quality as perceived by the human visual system.

## V. SIMULATION RESULTS

Shows the building, buildings, sailing, ocean and light house images are implemented MATLAB tool. All the images are divided into three part i.e. original image, resize image and compressed image.

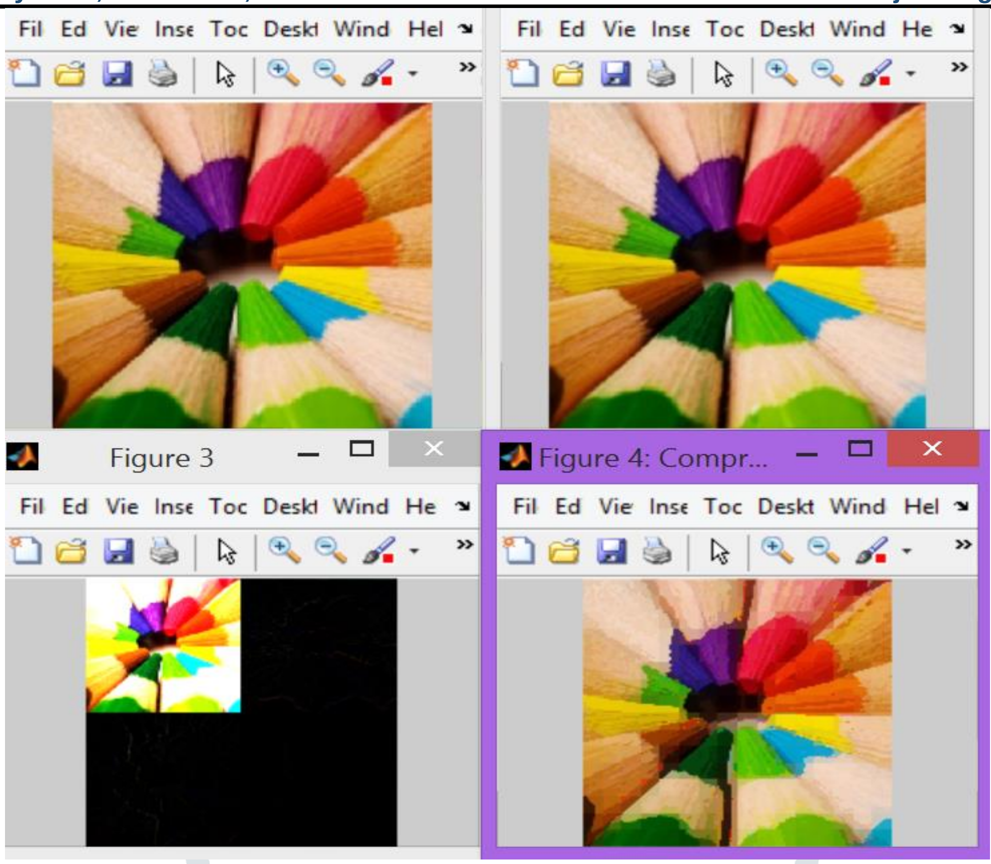


**Figure 5: Color Image Compression**

Table I: Experimental MSE Results for Different Types of Image

| **Image of Size 512×512** | **16×16 Block Pixel** | **32×32 Block Pixel** |
|---|---|---|
| Lena Image | 40.065 | 38.336 |
| Peppers Image | 40.321 | 38.91 |
| Color Image | 40.805 | 38.803 |
| Jetplane Image | 40.088 | 38.882 |

Table II: Experimental MSE Results for Different Types of Image

| **Image of Size 512×512** | **16×16 Block Pixel** | **32×32 Block Pixel** |
|---|---|---|
| Lena Image | 25.837 | 38.468 |
| Peppers Image | 24.782 | 36.871 |
| Color Image | 21.789 | 34.537 |
| Jetplane Image | 26.059 | 34.011 |

## VI. CONCLUSION

In this paper a spatial domain technique for image data compression, namely, the multi-level block truncation coding (ML-BTC) has been considered. This technique is based on dividing the image into non overlapping blocks and uses a two-level quantize. The ML-BTC technique has been applied to different grey level test image each contains.

The multi-level block partition encoder and decoder technique is presented. Such method is suitable in situations where image or image is compressed once but decoded frequently. It is clear that the decoding time due to spatial domain based compression is much less than that of the sub-band compression techniques.

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