A New Modified Fast Fractal Image Compression Algorithm in DCT Domain

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Abstract- **Medical Image Processing is the technique of analysing medical image such as CT, MRI for diagnostic and treatment purpose. The role of image compression is vital in domain of tele medicine for storage and transmission of medical data. In this project transform domain based compression algorithm is employed for the efficient compression and transfer of medical data. The Discrete Cosine Transform (DCT) based fractal image compression algorithm is employed for real time CT medical image. The result is validated by performance metrics Peak Signal to Noise Ratio (PSNR) and compression ratio. The algorithm was developed in MATLAB 2010a.**

Keywords— Peak Signal to Noise Ratio (PSNR), Quadtree Algorithm, Fractal Image Compressor, Compression Ratio(CR), Discrete Cosine Transform(DCT), Inverse Discrete Cosine Transform (IDCT).

I. INTRODUCTION

Fractal image compression is one of the technique in image compression that uses self-similarity in images. It has much interest due to its promise of high compression ratios at good decompression quality and it has the advantage of very fast decompression. Another advantage of fractal image compression is its multi resolution property and it is possible to zoom-in on sections of the image. Image compression addresses the problem of reducing the amount of data required to represent a digital image with no significant loss of information. This field significantly grows through the practical application of the theoretic work, when the probabilistic view of information and its representation transmission and compression.

Amit Kumar Biswas et al proposed Fractal image compression algorithm to encode the image. This algorithm enhance the reconstructed quality of image with high compression ratio [1]. Sharmila et al proposed (DCT) Discrete Cosine Transform to compress the image. The compression ratio of color image is calculated using PSNR value. It also reduce the noise of the decompressed images [2]. Chandan Singh Rawat et al proposed the (PSNR) Peak Signal to Noise Ratio and (SSIM) Structural Similarity Index Algorithm to compress the image. The color image is compressed using DCT in to similar blocks [3]. Gowri Sankar Reddy et al proposed an image compression algorithm based on uniform thresholding, using (BBP) Bits Per Pixel and (PSNR) Peak Signal to Noise Ratio algorithm. The main advantage is storage capacity is saved. [4]. Vinaysahu et al proposed an approach using DTCWT with high level filtering technique using PCA (Principle Component Analysis) algorithm. The performance was measured by parameters like MSE and PSNR which gives better results [5]. Kozhemiakin et al proposed the compression ratio prediction technique used for noisy and almost noise-free remote sensing images using DCT Algorithm. The methodology is used to describe iterative for CR (Compression Ratio) which does not require any compression or decompression histogram values V that is too smaller than image size [6].

Krishna et al proposed (DCT) Discrete Cosine Transform and (MSVQ) Multistage Vector Quantization to increase the image compression ratio. This methods also reduces the storage size of images [7]. Mayuri A. chavan proposed 2D integer wavelet transform of medical images to reduce the energy of Sub-bands. The global and local symmetries is based on 3D scalable lossless compression for medical image. The 2D integer wavelet transform is used to decorrelate the data [8]. Leila Makkaoui et al proposed image compression of (WCSNs) Wireless Camera Sensor Networks to decrease the energy sensors and to maintain a long Network lifetime. The Experimental of DCT based image compression algorithm allows the efficient trade-off between energy consumption and image distortion [9]. Tilo Ochotta et al proposed fractal image compression which is better when compared to other fractal methods. The total rate of partition is encoded with region edge map based on uniform partitions. Fractally the image will be reconstructed by sharper edges and contrast than JPEG 2000 from mild blocking artifacts [10].

II. MATERIALS AND METHODS

A new method for fractal image compression is used to reduce the encoding time. The analysis is done on different parameters such as encoding time, compression ratio, SSIM and PSNR. The most important point is that the encoding time was decreased by using predefined values instead of searching the contrast scaling factor. Image compression address the problem of reducing the amount of data required to represent a digital image with no significant loss of information.

The steps used in the image compression algorithm is as follows

- Read the input image to be compressed.
- Partition the image into range block of size $X \times X$ and select the corresponding domain blocks of size $2X \times 2X$, which contained range block located at the center of the domain blocks.
- Apply Discrete cosine transform on Range and Domain Blocks.
- DCT is split into domain pool and range pool.
- Apply Quad tree Algorithm for encoding.
- Calculate Compression Ratio.

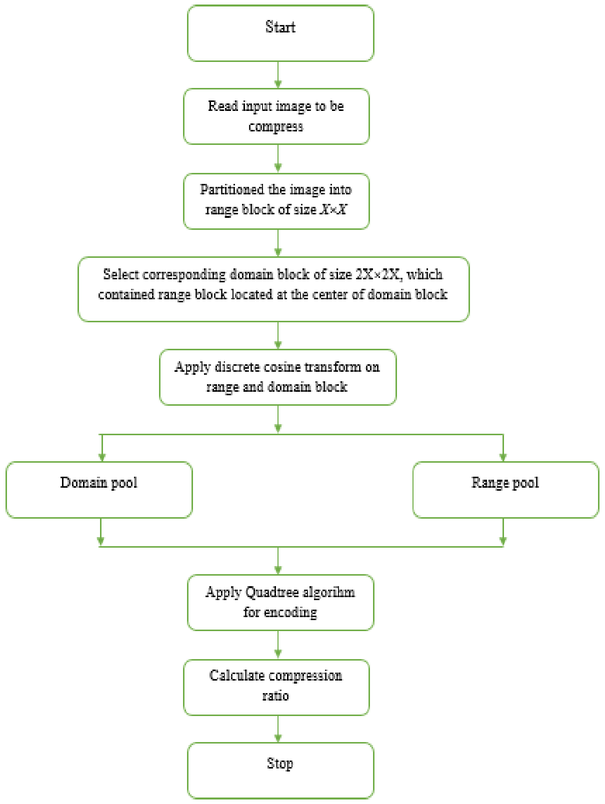

Figure 1: Proposed Fractal Image Compressor

At the first step of fractal coding, the image is partitioned into two non overlapping range blocks of size $X \times X$ where, X is a predefined parameter. Then a set of domain blocks is created from original image, taking all square blocks of size $2X \times 2X$ with integer step L, in horizontal and vertical directions. Three new domain blocks are Created by rotating clockwise in 90°, 180° and 270°. These three domain blocks and the original domain block are mirrored. In addition to the original domain block, we have 7 new domain blocks. These 7 new domain blocks are added to the domain pool. After constructing the domain pool, each range block will be partitioned. we must select the best domain block from domain pool and find an affine transformation that maps the selected domain block to it with minimum distance. The mentioned distance between a range block, R, and a decimated domain block, D, both with n pixels is defined as follows:

$$E(R, D) = \sum_{i=1}^{n} (sd_i + o - r_i)^2 \quad (1)$$

Where the best coefficient s and o are ,

$$s = \frac{<R-\bar{R}.1, D-\bar{D}.1>}{||D-\bar{D}.1||^2} \quad (2)$$

$$o = \bar{R} - s\bar{D} \quad (3)$$

Where <, >, R, D, $\bar{R}$ and $\bar{D}$ are inner product, range block, domain block, mean of R and mean of D respectively. Because of high computational cost of (2), it is convenient to search S across a pre-sampled set of [0,1], instead of calculating (2). The process of encoding described above can be done entirely in one step by ignoring the error values of mappings.

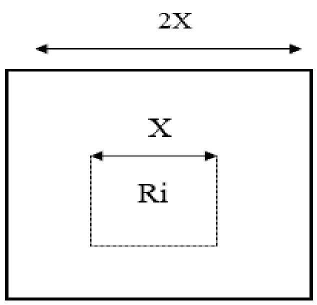

Figure 2: Position of range block and corresponding domain block.

Discrete Cosine transform is applied in the range and domain block to separate the domain and range pool. Let N be the positive integer. The one dimensional DCT of order n is shown by n x n matrix M. It is given as,

$$M_{ij} = a_i cos \frac{i(2j+1)\pi}{2n} \quad (4)$$

The first parameter is the compression ratio, expressing how much less there are the coded data than the data of the original raw image.

$$C_{Compression} R_{Ratio} = \frac{I_1}{I_2} \quad (5)$$

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PSNR is a metric for the ratio between the maximum possible power of a signal and the power of the decoded image with reduced fidelity of its representation. It is most commonly used to measure the quality of decoded signals or images. It is defined most easily via the mean square error (MSE) that is defined for two images B and B decoded as follows,

$$MSE = \frac{1}{VU}\sum_{i=0}^{V-1}\sum_{j=0}^{U-1}\left|B(i,j) - B_{Denoised}(i,j)\right| \quad (6)$$

PSNR is defined as

$$PSNR = 10\log_{10}\{\frac{[MAX(B)]^2}{MSE}\}$$

$$= 20\log_{10}[\frac{MAX(B)}{(MSE)^{\frac{1}{2}}}] \quad (7)$$

Here, MAX (B) is the maximum value of the numerical representation of a pixel luminance or chrominance component. Mostly, 8-bit values are used, and in this case, MAX (B) = 5255.

The SSIM index can be used to measure the similarity of two images. This index combines three different metrics. Let x5{xi|i51, 2, 3,…, N}, and y5v {yi|i51,2, 3,…, N} be the original and the test image, respectively. SSIM is defined as,

$$SSIM = Q = \frac{4\sigma_{XY}\bar{X}\bar{Y}}{(\sigma_X^2+\sigma_Y^2)(\bar{X}^2+\bar{Y}^2)} \quad (8)$$

Where,

$$\bar{X} = \frac{1}{N}\sum_{i-1}^{N} x_i,\ \bar{Y} = \frac{1}{N}\sum_{i=1}^{N} y_i$$

$$\sigma_x^2 = \frac{1}{N=1}\sum_{i=1}^{N}(x_i-\bar{X})^2,\ \sigma_y^2 = \frac{1}{N-1}\sum_{i=1}^{N}(y_i-\bar{Y})^2$$

$$\sigma_{xy} = \frac{1}{N-1}\sum_{i=1}^{N}(x_i-\bar{X})(y_i-\bar{Y}) \quad (9)$$

The SSIM indicates any distortion as a combination of three different factors: loss of correlation, luminance distortion and contrast distortion. In other words, Q in equation (7) can be rewritten as a product of three components

$$SSIM = Q = Q_1Q_2Q_3 = \frac{\sigma_{xy}}{\sigma_x\sigma_y}\frac{2\bar{X}\bar{Y}}{(\bar{X}^2)+(\bar{Y})^2}\frac{2\sigma_x\sigma_y}{\sigma_x^2+\sigma_y^2}$$

$$= s(x,y)^{\alpha}\times l(x,y)^{\beta}\times c(x,y)^{\gamma} \quad (10)$$

The first the correlation coefficient between x and y, which represents the degree of linear correlation between x and y, and the dynamic range is between 21 and 1. sx and sy can be considered as an estimate of the contrast in x and y. In practice, we use the metric described above, the image is windowed equally. Then, for each window, SSIM is used to find the average SSIM as follows,

$$\overline{SSIM}(X,Y) = \frac{1}{M}\sum_{j-1}^{M} SSIM(x_j,y_j) \quad (11)$$

Where X and Y are the original and the de-noised images, respectively, M is the number of the local windows in the image, xj and yj are the image contents at the jth local window.

III. RESULTS AND DISCUSSIONS

The first column represent the input human MRI image. Magnetic resonance imaging (MRI) is a medical imaging technique used in radiology to form pictures of the anatomy and the physiological processes of the body in both health and disease.

The second column represent the compressed image of the given input image. Data compression is the process of encoding data using a representation that reduces the overall size of data. Digital image compression is a method for reducing the total number of bits required to represent an image.

The third column represent the decompressed image. Decompression is accomplished by applying the inverse of each of the preceding step. Thus, the process starts with entropy decoding and proceeds to convert the run lengths to a sequence of zeros and coefficients. Coefficients are dequantized and Inverse Discrete Cosine Transform (IDCT) is performed to retrieve the decompressed image.

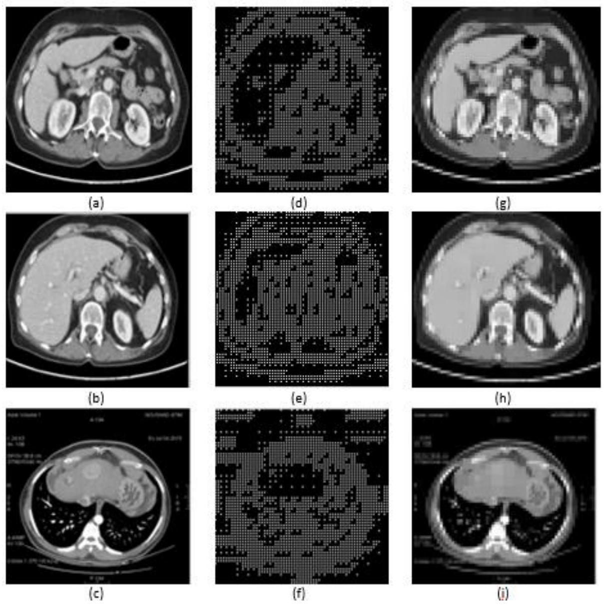

Figure 3. Output results of Abdomen CT/MRI images

Table I describes the performance matrix of Discrete Cosine transform with Elapsed time

TABLE: PERFORMANCE MATRIX OF DISCRETE COSINE TRANSFORM

Image Details	Time taken for compression	Time taken for decompression	PSNR	Compression Ratio
1	3.9320	51.266324	22.54428	7.973066
2	3.799529	46.242968	22.67624	8.786164
3	3.237347	42.388705	22.37382	9.211948

IV.CONCLUSION

A new method for fractal image compression is used. Different performance measures such as encoding time, compression ratio, SSIM and PSNR were analyzed. The most important point is that the encoding time was decreased by using predefined values instead of searching the contrast scaling factor. In addition, our analysis showed that domain pool reduction has a good performance for pool sizes less than 200, allowing shorter encoding times.

The algorithm has been verified with some well-known images, and the results have been compared with the state-of-the-art algorithms. The experiments show that the proposed algorithm has considerably lower encoding time, compared to the other algorithm with approximately the same quality of the encoded images. Also, the proposed method is better than the previous method based on entropy.

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