Fractal Image Compression Based on High Entropy Values Technique

Douaa Younis Abbaas¹, Jamila H. Saud¹, Shatha J. Mohammed²
¹Department of Computer Science, College of Science, Mustansiriyah University, IRAQ.
²College of Science, Mustansiriyah University, IRAQ.
*Correspondent Author Email: douaayounis89@gmail.com

Abstract
There are many attempts tried to improve the encoding stage of FIC because it consumed time. These attempts worked by reducing size of the search pool for pair range-domain matching but most of them led to get a bad quality, or a lower compression ratio of reconstructed image. This paper aims to present a method to improve performance of the full search algorithm by combining FIC (lossy compression) and another lossless technique (in this case entropy coding is used). The entropy technique will reduce size of the domain pool (i.e., number of domain blocks) based on the entropy value of each range block and domain block and then comparing the results of full search algorithm and proposed algorithm based on entropy technique to see each of which give best results (such as reduced the encoding time with acceptable values in both compression quality parameters which are C. R (Compression Ratio) and PSNR (Image Quality). The experimental results of the proposed algorithm proven that using the proposed entropy technique reduces the encoding time while keeping compression rates and reconstruction image quality good as soon as possible.

Keywords: Fractal Image Compression, Entropy, Image Quality, Domain Pool, Similarity, Encoding.

Introduction
The goal of image compression is to reduce the amount of data required to represent a digital image [1]. Fractal compression is a lossy compression method for digital images, based on fractals [2]. The idea of fractal image compression (FIC) also named full search algorithm was originally introduced by Barnsley in 1988 and the first practical FIC scheme was realized by Jacquin in 1992 [3] since each natural image has sub sections and the pixels of each subsection have great self-similarity to each other that is called Partitioned Iterated Function System or PIFS [4]. FIC is best suited for textures and natural images, relying on the fact that parts of an image often resemble other parts of the same image [2] which can be regarded as possessing fractal nature [5]. In full search algorithm, fixed block size partitioning will be used to generate the range and domain blocks. The main drawback of FIC is larger computational time in encoding stage because 8- symmetry mappings that must be tried to each domain block and then select the symmetry case of the domain block that led to least square error (lesser difference) and optimum matching when comparing this domain block with each range block. However, in this work, the proposed method combines the full search algorithm and entropy technique to reduce size of the domain pool (i.e., number of domain blocks) and then comparing it against the results of full search algorithm to see which one is better performance.

Article Info
Received 19/02/2015
Accepted 14/04/2015

© 2018 Authors and Al-Mustansiriyah Journal of Science. This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International Licenses.
with range block this caused that the number of comparisons between range and domain block is \(8n_r n_d\). Number of the range blocks can be calculated using \((N/n)^2\) while number of the domain blocks can be calculated using \((N - 2n + 1)^2\) where \(N\) is image dimension while \(n\) is block dimension.

In order to reduce the computation time, different optimization techniques have been proposed. The main objective of this paper is to develop an efficient optimization technique for FIC which is called “entropy technique” that involves performing the search in part of domain pool rather than over the whole domain pool by reducing the domain pool size based on entropy value of both range and domain blocks this make the domain pool more productive. Using proposed FIC based on entropy technique has two fundamental targets which are speeding up the encoding time by check the entropy value of all domain blocks in the domain pool, the domain blocks having high value of entropy threshold (\(\varepsilon\)) will be excluding while the domain blocks having low value of \(\varepsilon\) only will be selected. This technique will reduce size of the domain pool, therefore the matching stage pair of range and domain blocks will be achieved in faster time. Also the other target is keeping on quality of the reconstructed image good after their construction as well as increasing compression ratio. The balance of the paper is organized as follows: introduction to fundamentals of FIC scheme is given in section 1. The proposed encoding and decoding stages of the proposed algorithm based on entropy technique are described in sections 2 and 3. The experimental results of our proposed entropy technique and comparing this technique with full search algorithm are illustrated in sections 4-A and 4-B. Finally, some concluding remarks are given in section 5.

1. The Encoding Stage in Proposed FIC Based on Entropy Technique

As said before that full search algorithm is time consuming so that a new approach must be proposed to overcome this problem. In this paper, entropy technique will be used; it is information theory that provides the basic tools needed to deal with image representation directly and quantitatively. The proposed FIC based on entropy technique is similar to the full search algorithm expect few differences. See Figure 1 that explains the main steps of the proposed FIC based on entropy technique. The proposed entropy technique can be illustrated in the following points:

a. Generating Range and Domain Pools

Generating range and domain pools starting with loading the original image into its buffer to create the range image and generating the domain image from the range image by down sampling process using averaging method then the range and domain blocks must be formed to need them in the remaining steps in the encoding stage by partitioning the range and domain images using quad tree technique since the range blocks are non-overlapped to make the decoder capable of reconstruction the image while the domain blocks are allowed to be overlapped depend on the step size values where allowing the domain blocks to be overlapped improving quality of the reconstructed image. In proposed FIC we will use quad tree partitioning technique to generate these range and domain blocks since the reasons that make us use this partitioning technique is by using quad tree technique more acceptable quality of reconstructed images will be obtained as well as because each range block will be compared only with four domain blocks so the encoding time for FIC systems that use this technique will be less than these FIC systems that use fixed block size partitioning technique which this most important reason. Mean absolute error (MAE) which can be calculated using equation 1 is used to decide whether range and domain blocks partitioned or not since MAE of range and domain blocks are computed then comparing MAE of range block with MAE of domain block must be occurred if MAE difference of them within specific threshold then range and domain blocks are not partitioned (they are similar):

\[
\text{MAE} = \frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} |x(i, j) - y(i, j)| ...(1)
\]

Otherwise this means that these blocks are not similar then partitioning of these blocks will be applied. The specific threshold that used to decide whether MAE values of range and domain blocks are approximate or non is minimum block error (MBE) which its tested values in our work are \((0.1, 0.01, 0.001, 0.0001\) and \(0.00001\)). If the difference between MAE values of range and domain blocks are not partitioned (they are similar):
blocks are partitioned otherwise no partitioning process is implemented. The matching computation will be reduced in the proposed algorithm where the entropy values of the range and domain pools will be computed and used these values to find the best matching between pairs range-domain locks in an encoding stage.

b. Entropy Values Determination
After completing the partitioning process, the domain pool size is resulted very large, this size will be consume time in the encoding stage when searching in the domain pool to find the best matched domain block that satisfied least error for each pair range-domain blocks. In the best matched domain block that satisfied least error for each pair range-domain blocks. In the proposed algorithm, the entropy values will be computed from equation 2 to each range and domain blocks separately. In the encoding stage, the best matching between the entropy values of range with the entropy values of domain block can be found if these blocks satisfied the condition in equation 3:

\[
\text{entropy} = -\sum_{i=1}^{n} p_i \log p_i \ldots (2)
\]

\[
|\text{entropy}(R_i) - \text{entropy}(D_i)| \leq \varepsilon \ldots (3)
\]

Where: \( p \) is the probability value, \( D_i \) is the average of domain block, and \( \varepsilon \) is the entropy threshold. Before searching and matching processes, the entropy values of range and domain blocks must be tested to show whether the domain block satisfy this condition or not. In this paper entropy threshold \( (\varepsilon) \) determined to be in values from 0.1 to 0.9 where according to \( \varepsilon \) a decision will be made to determine if the domain block belong to the domain pool or not.

According to equation 3 the new reduced domain pool will be formed since if the difference of entropy values between range and domain blocks lesser than or equal to \( \varepsilon \) then this domain block will join to the domain pool. Otherwise the domain block will be discarded and excluded from the domain pool so the new domain pool consists of only the domain blocks that have low entropy value instead of all domain blocks this will lead to reducing number of the comparisons for finding the best matched domain block for each range block and then speeding up the encoding time. \( \varepsilon \) value will be controlled parameter in the
encoding stage, if ε value is high this mean that the encoding stage need long time to be done (large domain pool). But if ε value is small the encoding process need short time to compare the domain block in domain pool with suitable range block (small domain pool). This process will reduce the encoding time with acceptable quality of the reconstructed image.

c. Searching and Matching Processes

After computing the entropy values of all range and domain blocks, the searching and matching process among each range block and all overlapped domain blocks in the reduced domain pool size must be done but may be noticed that range and domain blocks must be at the same size since must not comparing range and domain blocks of different sizes.

In general, the best matched domain block must be found for each range block so that the error between each range block and all domain block will be computed based on their entropy values but before calculating the error the scale coefficient \( s_q \) must be calculated and quantized as well as index of the quantized scale coefficient must be computed. If the computed error lesser than minimum block error (MBE) then this domain block will consider the best matched block and information of the best matched domain block such as the position \((x_d, y_d)\) and index of quantized scale \( I_q \) will be stored in the compressed file (Frac) but the quantized offset coefficient doesn’t be saved in the compressed file because the offset coefficient doesn’t change the entropy value of the block. After that the searching process will continued for another range block.

Otherwise, if the computed error greater than minimum block error (MBE) then newly searching process in the reduced domain pool for the range block will be done until finding the best matched domain block with minimum error. The proposed encoding stage diagram can be shown in Figure 2. In this work, index of quantized scale coefficient will be stored in IFS code instead of quantized values of it to reduce the size of compressed file (to increase the compression ratio C. R) and to access to the quantized scale coefficient. Also, to increase the compression ratio, the values of \( x_d \) and \( y_d \) must be minimized.

At the end, result of the encoding stage is compressed file (code book file or IFS code) where the compressed files of both full search and proposed algorithms contain the similar information expect compressed file of the proposed algorithms doesn’t contain index of the quantized offset \( I_0 \). The compression information must be saved in header of the compressed IFS file before starting the encoding stage such image width \( W \), image high \( H \), block length, step size, no. of bit used to quantize scale coefficient, maximum and minimum scale coefficient, entropy threshold \( ε \) and MBE to make the decoder capable of reconstruction the original image from the compressed file. The decoder needs this information to reconstruct the original image.

2. The Decoding Stage

The decoding stage in proposed FIC based on entropy is similar to the decoding stage in full search algorithm since this process very fast when compared with encoding stage which considers the first advantage of decoding stage because no searching step for finding the best matched domain block for each range block which spent a lot of time. Any initial image can be taken such as zero images and then reconstructed the compressed image from it. To reconstruct the compressed image, the range image must be created by loading the initial image into a buffer and then domain image must be created by down sampling range image.

The same as to the decoding stage in full search algorithm, range and domain images must be partitioned using quad tree partitioning that used in encoding stage. Before starting the decoding stage, content of the header in IFS code must be extracted because they are necessary to integrate other parameters that the decoder need them also the quantized values of scale coefficient \( (s_q) \) must be de-quantized to their original values since we can arrive to these quantized scale coefficient by using quantized scale indexes as well as coordinate of the best matched domain block \((x, y)\) also must be reconstructed to their original value. Now, all data of IFS code become prepared to be using them in reconstruction operation since content of each domain block multiplied by de-quantized scale value to reconstruct the range blocks, these steps will continue until small or no change appear in quality of the reconstructed image.compression ratio (C. R), PSNR, bit rate (B. R) and mean square error (MSE) are calculated using the following equation to need them in section 4:
compression – ratio(CR)

\[
\text{CR} = \frac{\text{Original – image – size}}{\text{Compressed – image – size}} \quad \cdots (4)
\]

\[
\text{PSNR}(db) = 10 \log_{10} \left( \frac{(L-1)^2}{\text{MSE}} \right) \quad \cdots (5)
\]

\[
\text{MSE} = \frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} (x(i, j) - y(i, j))^2 \quad \cdots (6)
\]

\[
\text{Bit Rate} = \frac{\text{number of bits}}{\text{number of pixels}} = \frac{(8 \times \text{number of bytes})}{N \times N} \quad \cdots (7)
\]

Where: L is number of the grey levels in the image M, N is image dimensions, x(i, j) is the original image, y(i,j) is the reconstructed image, N is high or width of an image.

**Experimental Results**

Experimental results were implemented using Visual Basic (Ver.6.0). It is tested on laptop Acer, 2 GHz processor. Entropy technique had been tested specially on bitmap grey scale images of size n x n since in this thesis we will use lenna, golden hill, girl, train and plane images of size (256 x 256 pixel, 8-bits) as a test images as well as other color images of size (256 x 256 pixel, 24-bits) are also used in experimental tests.

**Results of the Decoding (Reconstruction) Stage Based on Entropy Technique**

The sample images are compressed using MBE, block length ,step size, scale bits ,maximum scale and entropy threshold (\( \varepsilon \)) parameters since these parameters are set to be (0.0001, 4, 2, 11, 0.9, 0.8) respectively, Figure 3 can be shown to observe results of applying the proposed algorithm on these sample images. Newly, the encoding parameters will be set again to be (0.001, 8, 2, 12, 0.8, and 0.7) respectively to show the new effects on these sample images in Figure 4. Because in the proposed entropy technique, the offset coefficient doesn’t be used in compression process since as said in section 2 the offset coefficient don’t change the entropy value of the block so the memory of offset coefficient will be exploited to enlarge the number of bits that used to store scale coefficient to arrive to the 12-bit this give chance for obtaining on best results of the reconstructed images using proposed technique.

**Comparing Results of Full search algorithm and Proposed FIC Based on Entropy Technique**

To verifying from any proposed algorithm give the required results the comparing between this proposed algorithm and traditional algorithm must be done so that results of the proposed algorithm that use quad tree partitioning will be compared with results of full search algorithm that use fixed block partitioning and sure from does that proposed algorithm speed the encoding time and reconstruct the images with acceptable C. R and PSNR or not, see Tables 1, 2 and 3. See Figures 5, 6 and 7 that show the reconstructed images in both full search algorithm and proposed algorithm according to the encoding parameter values which determined in Tables 1, 2 and 3.
Figure 2: The proposed encoding stage diagram.
Original Image: Lenna Image (24-bit)
The Reconstructed Image
E. T=120.230 sec
C. R=52.63
PSNR=21.230 dB
MSE=489.76
MAE=38.390
B. R=16.313 bpp

Original Image: Lenna Image (8-bit)
The Reconstructed Image
E. T=109.51 sec
C. R=69.066
PSNR=27.155 dB
MSE=125.17
MAE=8.241
B. R=12.510 bpp

Original Image: Rose Image
The Reconstructed Image
E. T=124.74 sec
C. R=46.241
PSNR=27.254 dB
MSE=122.35
MAE=16.675
B. R=12.975 bpp

Original Image: Fruits Image
The Reconstructed Image
E. T=120.95 sec
C. R=35.366
PSNR=19.586 dB
MSE=715.17
MAE=43.920
B. R=10.858 bpp

Original Image: Golden Hill Image
The Reconstructed Image
E. T=109.14 sec
C. R=23.583
PSNR=22.863 dB
MSE=336.32
MAE=24.784
B. R=4.071 bpp

Figure 3: Reconstructed images with its values
Abbaas et al.  
Fractal Image Compression Based on High Entropy Values Technique  
2017

Figure 4(a): Reconstructed images with its values

Figure 4 (b): Reconstructed images with its values
Newly, the encoding parameters will be set again to be (0.001, 8, 2, 12, 0.8, 0.7) respectively to show the new effects on these sample images in Figure 4 (a and b).

Because in the proposed entropy technique, the offset coefficient doesn’t be used in compression process since as said in section 2 the offset coefficient don’t change the entropy value of the block so the memory of offset coefficient will be exploited to enlarge the number of bits that used to store scale coefficient to arrive to the 12-bit this give chance for obtaining on best results of the reconstructed images using proposed technique.

Comparing Results of Full search algorithm and Proposed FIC Based on Entropy Technique

To verifying from any proposed algorithm give the required results the comparing between this proposed algorithm and traditional algorithm must be done so that results of the proposed algorithm that use quad tree partitioning will be compared with results of full search algorithm that use fixed block partitioning and sure from does that proposed algorithm speed the encoding time and reconstruct the images with acceptable C. R and PSNR or not, see Tables 1, 2 and 3. See Figures 5, 6 and 7 that show the reconstructed images in both full search algorithm and proposed algorithm according to the encoding parameter values which determined in Tables 1, 2 and 3. Finally, the main important reasons that make the proposed encoding stage faster than the encoding stage in full search algorithm will be explained in the following points:

1-Using quad tree partitioning technique which reducing the encoding time of proposed FIC technique since every range block will compared with only 4- domain block in every search process of finding best matched pair of range – domain blocks while in the full search algorithm fixed block partitioning is used which slowing the encoding time since every range block will compared with all domain blocks in every comparing time.

2-Reducing size of the domain pool according to the entropy threshold ($\varepsilon$) participate in decreasing size of the searching space that led to reducing the number of comparing for finding the best matched domain block for each range block.
Table 1: Comparing results of full search and proposed algorithms

The encoding parameters of both algorithms are block length=4, MBE=0.00001, step size=2, scale bits=7, offset bits=10 (only for full search algorithm), MaxScale =1, $\epsilon=0.6$

**Experimental Results of Full search algorithm**

| Image Name | E. T | C. R | PSNR  | MSE   | MAE  | B. R |
|------------|------|------|-------|-------|------|------|
| Lenna (24-bit) | 821.16 | 8.476 | 33.873 | 26.651 | 3.222 | 2.831 |
| Lenna (8-bit) | 803.26 | 11.088 | 31.320 | 147.970 | 9.184 | 2.164 |
| Fruits | 834.68 | 8.387 | 31.094 | 50.538 | 4.234 | 2.861 |
| Golden Hill | 796.41 | 11.291 | 36.747 | 13.751 | 1.418 | 2.126 |
| Mandrill | 901.70 | 8.534 | 30.622 | 56.352 | 5.302 | 2.812 |
| Girl | 788.07 | 11.192 | 40.898 | 5.287 | 1.288 | 2.144 |
| Rose | 436.83 | 8.957 | 42.917 | 3.321 | 1.757 | 2.680 |
| Train | 732.58 | 10.956 | 25.230 | 195.01 | 8.924 | 2.191 |
| Lake | 233.28 | 8.073 | 33.413 | 29.631 | 3.350 | 2.675 |
| Plane | 805.64 | 11.637 | 36.031 | 16.215 | 1.909 | 2.062 |

**Experimental Results of Proposed FIC Based on entropy technique**

| Image Name | E. T | C. R | PSNR  | MSE   | MAE  | B. R |
|------------|------|------|-------|-------|------|------|
| Lenna (24-bit) | 121.11 | 25.429 | 26.396 | 149.11 | 16.912 | 8.494 |
| Lenna (8-bit) | 105.41 | 11.088 | 24.611 | 224.89 | 17.937 | 2.164 |
| Fruits | 120.65 | 41.937 | 25.931 | 165.94 | 13.232 | 14.307 |
| Golden Hill | 107.03 | 11.291 | 24.449 | 233.43 | 22.593 | 2.126 |
| Mandrill | 120.11 | 34.132 | 25.453 | 185.25 | 16.674 | 11.249 |
| Girl | 110.29 | 33.576 | 35.451 | 18.531 | 4.172 | 6.433 |
| Rose | 121.54 | 53.426 | 35.826 | 16.997 | 5.653 | 16.172 |
| Train | 111.59 | 32.867 | 24.503 | 230.54 | 9.644 | 6.572 |
| Lake | 123.46 | 8.973 | 29.851 | 67.293 | 2.095 | 2.675 |
| Plane | 106.56 | 58.185 | 29.144 | 79.182 | 8.345 | 10.312 |

The reconstructed images using full search algorithm

The reconstructed images using proposed algorithm
Figure 5: Comparing in reconstructed images between full search algorithm and proposed algorithm based on entropy technique (using parameter values in Table 1).

Table 2: Comparison results between full search and proposed algorithms

The encoding parameters of both algorithms are block length=4, MBE=0.00001, step size=2, scale bits=9, offset bits=6 (only for full search algorithm), MaxScale =0.8, ε=0.7

| Image Name   | E. T  | C. R  | PSNR  | MSE   | MAE   | B. R  |
|--------------|-------|-------|-------|-------|-------|-------|
| Lenna (24-bit) | 903.94 | 9.151 | 32.758 | 34.457 | 3.953 | 2.623 |
| Lenna (8-bit) | 802.67 | 11.849 | 29.860 | 67.140 | 5.455 | 2.026 |
| Fruits       | 899.85 | 9.120 | 30.363 | 59.799 | 4.920 | 2.632 |
| Image Name   | E. T    | C. R    | PSNR  | MSE    | MAE    | B. R    |
|-------------|---------|---------|-------|--------|--------|---------|
| Lenna (24-bit) | 119.34  | 45.757  | 25.402 | 187.41 | 15.482 | 13.113  |
| Lenna (8-bit)  | 109.50  | 35.547  | 22.040 | 406.425| 33.302 | 6.071   |
| Fruits       | 124.63  | 45.600  | 24.223 | 245.88 | 19.944 | 13.158  |
| Golden Hill  | 114.41  | 60.695  | 22.687 | 350.20 | 33.173 | 9.886   |
| Mandrill     | 120.69  | 18.510  | 26.784 | 136.32 | 11.901 | 5.187   |
| Girl         | 110.16  | 72.344  | 35.659 | 17.666 | 3.416  | 11.943  |
| Rose         | 115.91  | 38.560  | 30.690 | 55.972 | 13.740 | 9.958   |
| Train        | 109.39  | 46.477  | 19.523 | 725.60 | 31.307 | 8.262   |
| Lake         | 121.80  | 9.674   | 32.117 | 39.931 | 4.216  | 14.886  |
| Plane        | 108.88  | 62.578  | 25.835 | 169.64 | 17.276 | 9.588   |

The reconstructed images using the full search algorithm are compared with the images reconstructed using the proposed algorithm.
Figure 6: Comparison in reconstructed images between full search algorithm and proposed algorithm using based on entropy technique (using parameter values in Table 2).

Table 3: Comparison results between full search and proposed algorithms.

| Image Name     | E. T  | C. R  | PSNR  | MSE   | MAE   | B. R  |
|----------------|-------|-------|-------|-------|-------|-------|
| Lenna (24-bit) | 324.53| 7.950 | 33.269| 30.630| 3.441 | 3.019 |
| Lenna (8-bit)  | 362.28| 10.483| 30.482| 58.191| 4.520 | 2.894 |
| Fruits         | 403.75| 7.872 | 30.623| 56.326| 4.480 | 3.049 |
| Golden Hill    | 377.602| 10.664| 36.048| 16.151| 1.536 | 2.251 |
| Mandrill       | 416.15| 8     | 30.140| 62.960| 5.623 | 2.999 |
| Girl           | 279.52| 10.575| 39.931| 6.605 | 1.480 | 2.269 |
| Rose           | 102.85| 8.610 | 41.655| 4.441 | 1.391 | 2.787 |
| Train          | 308.44| 10.364| 24.322| 240.32 | 9.879 | 2.316 |
| Lake           | 341.77| 8.404 | 32.743| 34.572| 3.619 | 2.856 |
| Plane          | 393.93| 10.972| 34.821| 21.428| 2.169 | 2.187 |

**Experimental Results of Proposed FIC Based on entropy technique**

| Image Name     | E. T  | C. R  | PSNR  | MSE   | MAE   | B. R  |
|----------------|-------|-------|-------|-------|-------|-------|
| Lenna (24-bit) | 54.48 | 31.799| 27.332| 120.174| 11.592| 12.076|
| Lenna (8-bit)  | 47.45 | 31.449| 29.799| 68.168 | 4.927 | 6.868 |
| Fruits         | 54.55 | 7.872 | 30.346| 60.04  | 4.602 | 3.049 |
| Golden Hill    | 48.14 | 53.319| 26.155| 157.59 | 14.487| 11.253|
| Mandrill       | 54.82 | 8     | 22.782| 342.63 | 29.341| 2.100 |
Abbaas et al. Fractal Image Compression Based on High Entropy Values Technique 2017

|      | 47.73 | 10.575 | 31.586 | 45.127 | 4.140 | 2.269 |
|------|-------|--------|--------|--------|-------|-------|
| Girl | 53.26 | 49.951 | 42.166 | 3.949  | 1.202 | 17.297 |
| Rose | 49.16 | 41.457 | 17.851 | 1066.5 | 41.579 | 9.263 |
| Train| 55.32 | 8.385  | 29.272 | 76.886 | 7.535 | 2.862 |
| Lake | 48.02 | 43.888 | 29.399 | 74.662 | 6.928 | 8.750 |

The reconstructed images using full search algorithm

The reconstructed images using proposed algorithm
Figure 7: Comparison in reconstructed images between full search algorithm and proposed algorithm based on entropy technique (using parameter values in Table 3).

Conclusions
The experimental results in Tables 1, 2 and 3 which include 10 grey scale and color images of size 256 × 256 indicate that the proposed FIC algorithm based on entropy technique reconstructed the images with faster E. T and acceptable C. R as well as good quality of the reconstructed image.

The resulted C. R by proposed algorithm within the values that ranged from 7.872 to 72.344 which consider acceptable values when compared with C. R values of full search algorithm that ranged from 7.950 to 12.619 this means that the proposed algorithm reconstruct the images with C. R values better than C. R values of full search algorithm also the proposed algorithm reconstruct the images with good PSNR values which ranged from 17.851 dB to 42.166 dB that close to PSNR values of full search algorithm which included in values from 24.120 dB to 42.917 dB.

Relatively E. T, must be noticed from the mentioned tables that the highest E. T value of full search algorithm (for step size is 2 of Mandrill image) was 913.49 sec while the highest E. T value of the proposed algorithm (for the same step size of Mandrill image) was 120.69 sec this means that E. T of full search algorithm decreased about 792.8 sec where the main target from the proposed algorithm is breaking the slowing encoding time problem after then the secondary targets is to reconstruct the images with acceptable C. R and good PSNR that also invoked by the proposed algorithm as shown from results of the previous Tables.

References
[1] JyotiBholaand SimarpreetKaur, ”Encoding Time Reduction Method For The Wavelet Based Fractal Image Compression”, International Journal of Computer Engineering Science (IICES),Vol.2, Issue 5, May 2012.
[2] S. Michael Vanitha and K. Kuppusamy, ”Survey On Fractal Image Compression”, International Journal of Computer Trends and Technology (IJCTT), Vol.4, May 2013.
[3] Yih-Lonlin and Wen-Linchen, "Fast Search Strategies For Fractal Image Compression", Department of Information Engineering, J-Shou University Kaohsiung, 840 Taiwan, Journal Of Information Science and Engineering 28, 2012.
[4] Mahdi Jampour, Mahdi Yaghoobi and Maryam Ashourzadeh, "Fractal Images Compressing By Estimating The Closest Neighborhood With Using Of Schema Theory", Journal of Computer Science 6 (5): 591-596, 2010.
[5] K. Revathy and M. Jayamohan, "Dynamic Domain Classification For Fractal Image Compression”, International Journal of Computer Science & Information Technology (IJCSIT), Vol.4, No 2, April 2012.