



Comparative analysis of various Image compression techniques for Quasi Fractal lossless compression

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Received : 08th May 2020, Accepted : 23rd August 2020

Abstract: The most important Entity to be considered in Image Compression methods are Paek to signal noise ratio and Compression ratio. These two parameters are considered to judge the quality of any Image.and they a play vital role in any Image processing applications. Biomedical domain is one of the critical areas where more image datasets are involved for analysis and biomedical image compression is very, much essential. Basically, compression techniques are classified into lossless and lossy. As the name indicates, in the lossless technique the image is compressed without any loss of data. But in the lossy, some information may loss. Here both lossy & lossless techniques for an image compression are used. In this research different compression approaches of these two categories are discussed and brain images for compression techniques are highlighted. Both lossy and lossless techniques are implemented by studying it's advantages and disadvantages. For this research two important quality parameters i.e. CR & PSNR are calculated. Here existing techniques DCT, DFT, DWT & Fractal are implemented and introduced new techniques i.e Oscillation Concept method, BTC-SPIHT & Hybrid technique using adaptive threshold & Quasi Fractal Algorithm.

Keywords: Adaptive Threshold, Oscillation Concept, BTC-SPIHT, Quasi Fractal, Morphological Filter, CR, PSNR

1. Introduction

Lossy image compression technique is generally not preferred as it leads to loss of data and consumes more time for processing. Even though the required time for processing an image is more the lossy compression has special importance in compression of medical images. BY choosing best compression algorithms, we can reduce the required processing time. Commonly used image compression techniques fall under the category of lossy and lossless compression. Most challenging part of research is to develop an efficient compression algorithm. Many algorithms are so far developed for achieving better results. Due to compression method there

is possibility of loss in useful information, which has been used for researchers and practitioners. Some operations like enhancement may steer to further deterioration hence there is need of efficient method of image compression. Lossless compression as a better option as a remedy. Many lossless schemes are based on linear prediction and interpolation.

Scientific art and better solution for saving high data and reducing size is to compress images. Daily incalculable number of images is compressed & decompressed. Web pages & high-resolution cameras are having images and compressed using this technology.

Oscillation Concept method, BTC-SPIHT & Hybrid technique using adaptive threshold & Quasi Fractal Algorithm used for the compression.

1.1 CR & PSNR

For this research some important quality parameters i.e. CR, PSNR are calculated.

Here existing techniques DCT, DFT, DWT & Fractal are implemented. Out of which Fractal gives us better results. By implementing Fractal image compression, got the values of CR & PSNR as 3.51 & 31.45 respectively. Also by using fractal, getting value of MSE which is quite large, indicating quality of image is not good [1,2].

For improving CR and quality new method has been introduced. The new proposed methodology suggests that in every image there is variation in grey scale intensities, these variations are nothing but oscillations in an image. This concept is utilized to find out the variations in biomedical images, appropriate oscillations are considered for image compression.

By repeating the process we can obtain the Principal part from image. It is continued till better quality of Principal component. Here good quality is obtained by extracting Principal component. It gives better level of compression. It is explained as continuous signal just for understanding purpose. Finally achieved better results i.e. CR & PSNR are 4.32 & 32.56 respectively and value of MSE also reduced compared to existing Fractal technique [3].

Improving the Compression Ratio (CR) is essential and becomes big challenge in the field of medical. For improving results enhancement is used before image compression. Here image enhancement techniques is used. For enhancement of an image CLAHE and Decorrelation Stretch DCS algorithms are used. By Enhancement an image before compression better results are achieved i.e CR is 5.11 and PSNR is 32.77. These results are better than existing methods. Also achieved good image quality compared to Fractal & Oscillation concept used for compression of an image [4].

Oscillation concept is basically used as lossy image compression techniques. In the direction of improving results hybrid techniques are developed. In the hybrid technique two different algorithms on ROI & Non-ROI are applied. On ROI Lossless & for Non-ROI Lossy image compression technique has been used.

Here compared all existing techniques with implemented algorithms. Also taken literature review and concluded that there is need of new improved algorithm which will give us improved values of quality parameters (CR, PSNR, and MSE & MSSIM). Hence new hybrid algorithms are introduced.

Firstly hybrid algorithm is implemented using BTC & SPIHT. BTC is lossy compression technique and SPIHT is lossless. This hybrid algorithm is used after enhancement. Using this hybrid technique achieved better results than enhancing an image before compression. CR & PSNR are improved 5.65 & 33.01 respectively and also archived better image quality [5].

For refinement and reaching towards better quality of an image, developed improved hybrid coding algorithm for image compression. Here Morphological filter & adaptive threshold are used for refinement, and used Quasi Fractal & Oscillation concept for developing new hybrid algorithm. Oscillation concept is lossy image compression technique hence applied it on Non-ROI. Quasi fractal is lossless image compression technique applied on ROI.

The experimental results shows that better CR with acceptable PSNR has been achieved using hybrid technique based on Morphological band pass filter and Adaptive thresholding for ROI. Here, innovative hybrid technique gives the CR 24.61 which improves a lot than oscillation concept method with enhancement which is 5.11. Especially PSNR is also retained and bit improved i.e. 33.51. This hybrid technique gives better quality of an image.

1.2 Methodology

Now a days various image compression techniques are used by researchers. DCT, DFT, DWT & Fractal are most commonly used existing image compression techniques. In order to achieve better results than these existing techniques we have implemented oscillation concept method [6,7].

For compression, we can use MRI, CT & PET image. Both MRI and CT scan are used for detailing of brain images. MRI or CT images are used for Image compression which is effectively used for analysis of brain images. Here we have selected brain image for research. MRI is most effective in brain images hence we have selected MRI brain image for research.

Lossy and Lossless, are the two techniques of image compression. These compression techniques have their own pros and cons. Hybrid technique can be implemented to utilize advantages of both Lossy and Lossless techniques. New approach may find maximum limit of compression up to which exact region of interest could be extracted. Residual part of biomedical images could be reutilized to obtain accurate result. Possible loss of useful clinical information in biomedical images could be avoided [8-19].

To reduce digital image we can use Lossless or, “reversible” compression which offers reduction in file size and Lossy or “irreversible” compression allows a far greater size reduction.

Here, we have selected brain image. By using biomedical compression we are applying different image compression algorithms on brain images and achieving better values of CR& PSNR. Brain image compression is well known as sub field in biomedical image compression. For analyzing & diagnosing brain images are compressed in an effective manner to reduce the storage space.

Here hybrid technique is proposed to get the benefits of lossy and lossless compression techniques for medical image compression.

An application that requires image compression are many, some of them are mentioned as below.

- 1) Medical Imaging
- 2) Internet
- 3) Business
- 4) Multimedia
- 5) Satellite Imaging

This thesis mainly explains following methods for compression of brain images.

- 1) Image Compression using Oscillation Concept.
- 2) Oscillation Concept Method with Enhancement techniques.
- 3) Image Compression using Hybrid Techniques.

2. Image compression Techniques

2.1. Discrete Cosine Transform (DCT)

Many researches has found applications in image compression. All JPEG images use the Discrete Cosine Transform as the initial stage for compression. DCT is an orthogonal transformation that is very widely used in image compression. [20, 21] The one-dimensional DCT of a sequence.

$f(x)$, $0 \leq x \leq N-1$ is defined as

$$F(u) = \alpha(u) \sum_{x=0}^{N-1} f(x) \cos \left[\frac{\pi(2x+1)u}{2N} \right]; 0 \leq u \leq N-1$$

2.2 Discrete Fourier Transform (DFT)

It is a fundamental transform in DSP. Used for applications in fast convolution, image processing and frequency analysis etc. To compute the DFT efficient fast algorithms are exist. The DFT pair is given by

$$F(u) = \frac{1}{N} \sum_{x=0}^{N-1} f(x) e^{\frac{j2\pi ux}{N}}$$

For $u = 0, 1, 2, N-1$

And

$$F(x) = \sum_{u=0}^{N-1} F(u) e^{\frac{j2\pi ux}{N}}$$

For $x = 0, 1, 2, N-1$

The values $u = 0, 1, 2, N-1$ in the DFT given in equation corresponds to samples of the continuous transform at values $\Delta u, 2\Delta u, (N-1) \Delta u$. [3,23].

2.3 Discrete Wavelet Transform (DWT)

It is an important method for image compression. Wavelets are signals which have an irregular shape. It work on limited duration. It integrates to zero hence term “Wavelet”. It provides high CR due to property of energy compaction. It partitions a signal into a set of functions. [4,5,12]

2.4 Fractal Transform

It is new technique which encoding image compactly. Fractal technique was used in computer graphics for modelling natural phenomenon. The decoded image has no natural size, it can be decoded at any size. Fractals are Iterated Functions Systems (IFS). Fractal image interpolation may prove useful in multimedia applications. [6,7]

2.5 Oscillation Concept

A new approach in image compression is “Oscillation concept”. Theory of oscillations in images introduced by this method. Oscillations means vibrations and variations. In the pixel of an image vibrations are there w.r.t x & y axis. These oscillations are used for compression of an image, For improving CR this is better method. For biomedical images, appropriate oscillations are considered for image compression.

We can achieve principal part of an image by repeating the process & it will continued till better quality obtained. By extracting PC better quality is achieved [20]

3 Hybrid Image Compressions

In this hybrid coding following Nobel techniques are used as hybrid image compression techniques for achieving better results. Here by combining of two techniques (Lossy & Lossless), developing hybrid model.

Here used lossy & lossless techniques for developing hybrid model, and will get good level of compression by using lossy technique and due to lossless technique our PSNR and MSE will go better than the old algorithms. [8-14,18]

Here by using following hybrid models for compression of biomedical images.

- 1) BTC-SPIHT
- 2) Oscillation Concept & Quasi fractal method.

3.1 Block Truncation Coding (Btc):

For digitized gray scale images BTC has used. BTC uses moment preserving quantization method. For retaining visual quality of the reconstructed image this method is used.

3.2 Set Partitioning in Hierarchical Trees (Spiht):

SPIHT is Wavelet-based image compression method. DWT block has used for sending information which outputs DWT coefficients of the original image.

Data bit stream manner is output of SPIHT encoder which encodes the output. This bit stream send through SPIHT decoder & IDWT block, gives reconstructed image back

3.3. Hybrid Coding Using Quasi Fractal & Oscillation Concept

3.3.1 Lossless Fractal Image Compression (LFIC):

It is new method to code & decode images. It is simple method to regenerate images without data loss. Fractal based coding algorithms are standard fractal coding, Quasi lossless fractal coding & Improved Quasi lossless fractal coding. These algorithms are evaluated by checking their ability of compress MRI based CR, PSNR and encoding time. These new lossless fractal methods perform better than existing fractal coding.

This assures applicability of lossless fractal image compression in medical field. Application of fractal compression to medical images would allow much higher CR with good picture quality. Quasi lossless fractal coding has been used for development of hybrid technique. [1,2]

3.3.2 Morphological Filters:

Multilevel open operations are there which are just like a LPF, which eliminates the structures of the image. A morphological BPF is the difference between two multilevel open operations with different structuring elements MBF is introduced for detecting micro-calcifications. Is has implemented by opening the original image two times with two different structure elements respectively and also subtracting one opened image using another one. Multilevel morphological operations used concept of umbra ($U []$) and top ($T []$) surface. [15,17,19]

3.3.3 Detecting Roi & Non-Roi Portions :

- a) At first we need to separate the brain portion from the whole image because most of the background pixels are black i.e. pixels with zero intensity. So excluded those pixels are

also helpful to reduce the amount of bits during transmission and used for reasonable CR.

- b) Bounding box is a technique used to separate the brain portion from background. Bounding box is also used to extract the ROI produced by watershed algorithm.
- c) ROI is selected using bounding box is shown in Figure 3.1(b).

The extracted brain portion from the whole image is selected as ROI portion and is shown in Figure 3.1 (c).

A. Methodology for ROI

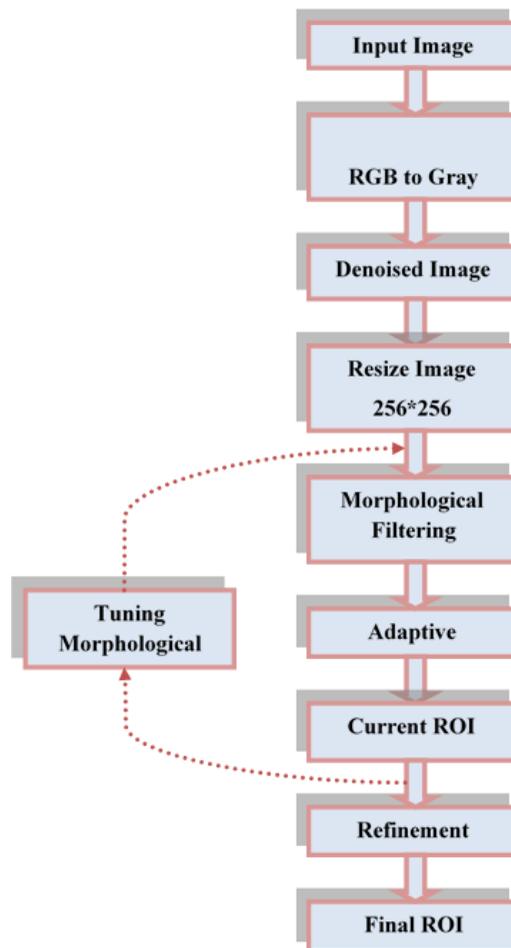


Figure 1. Methodology for ROI

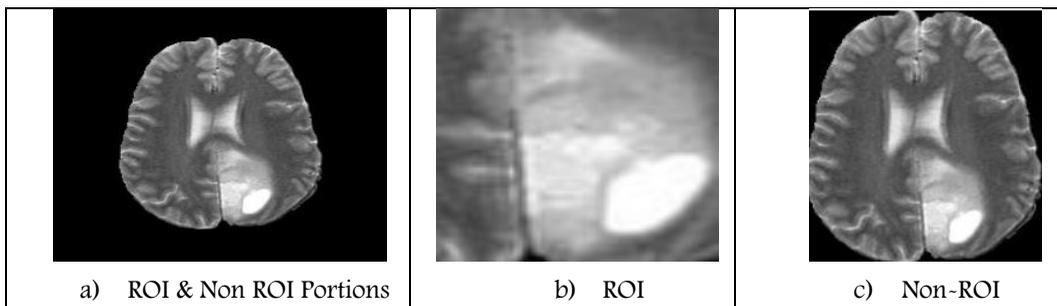


Figure 2. Brain image ROI & Non-ROI

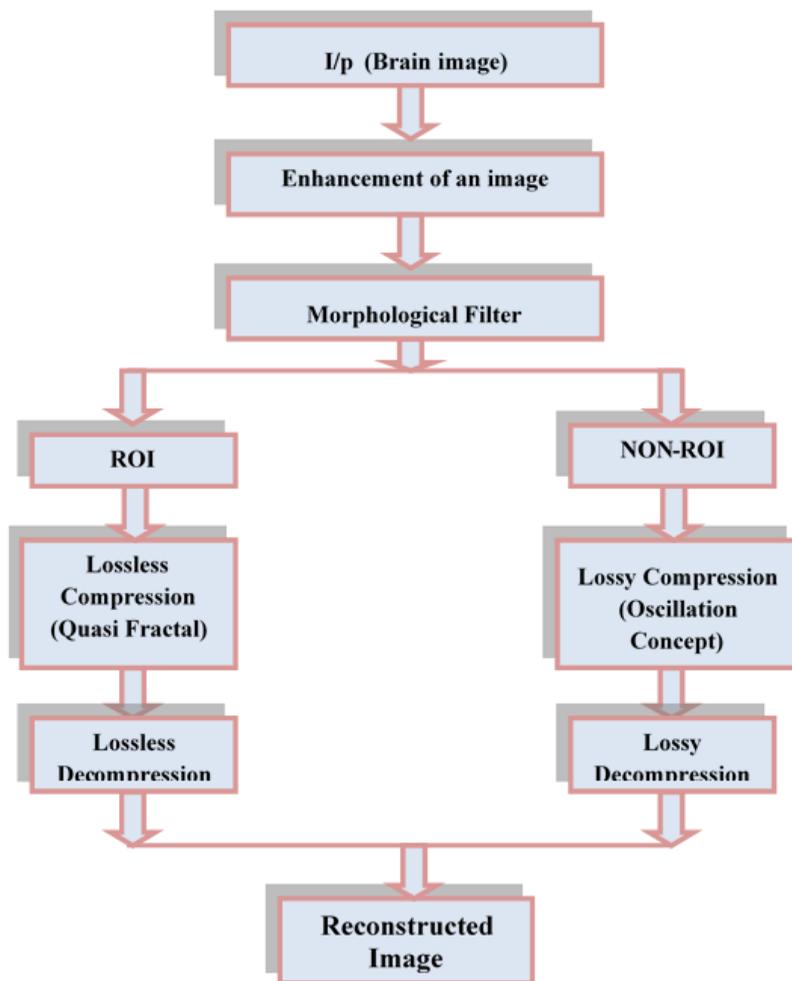


Figure 3. Hybrid Method Flow

3.4 Hybrid Method Flow

1. Key factors of innovative hybrid method are morphological filter & adaptive threshold.
2. This methodology is totally based on multilevel operation. By using this methodology we can achieve required ROI.

Hybrid algorithm is developed using Lossy and Lossless image compression techniques. Here for Non-ROI region lossy image compression technique is used and for ROI Lossless image compression technique is used. For Lossy compression oscillation concept and for lossless image compression Quasi fractal technique is used. This technique is developed for achieving better results. Hybrid techniques for compression of an image of brain use following steps as shown in figure 3.

3.5 Adaptive Threshold:

In image processing most commonly used operation is thresholding a greyscale image with a fixed value to get a binary image. Neighbouring pixel intensities are important for deciding the threshold value at each pixel location. Adaptive thresholding is used for partitioning the original image into certain sub images and utilize global thresholding techniques for each sub image.

3.6 Algorithm For Quasi Fractal & Oscillation Concept Method

- 1 Read Input Image
- 2 Convert RGB to Gray image
- 3 De-noise an image
- 4 Resize image into 256 * 256
- 5 Filtration by using Morphological Filters
- 6 Apply Adaptive thresholding
- 7 Find current ROI
- 8 Repeat procedure by tuning morphological filter for Refinement.
- 9 Find Final ROI
- 10 Find ROI
- 11 Apply Lossless Compression Technique over final ROI.
- 12 Apply Lossy Compression Technique on Non ROI.
- 13 Combine O/P images of Step 11& Step 12.

14 Show reconstructed compressed image.

4. Result and Discussion

4.1 Results of Hybrid Method (using Oscillation & Quasi Fractal)

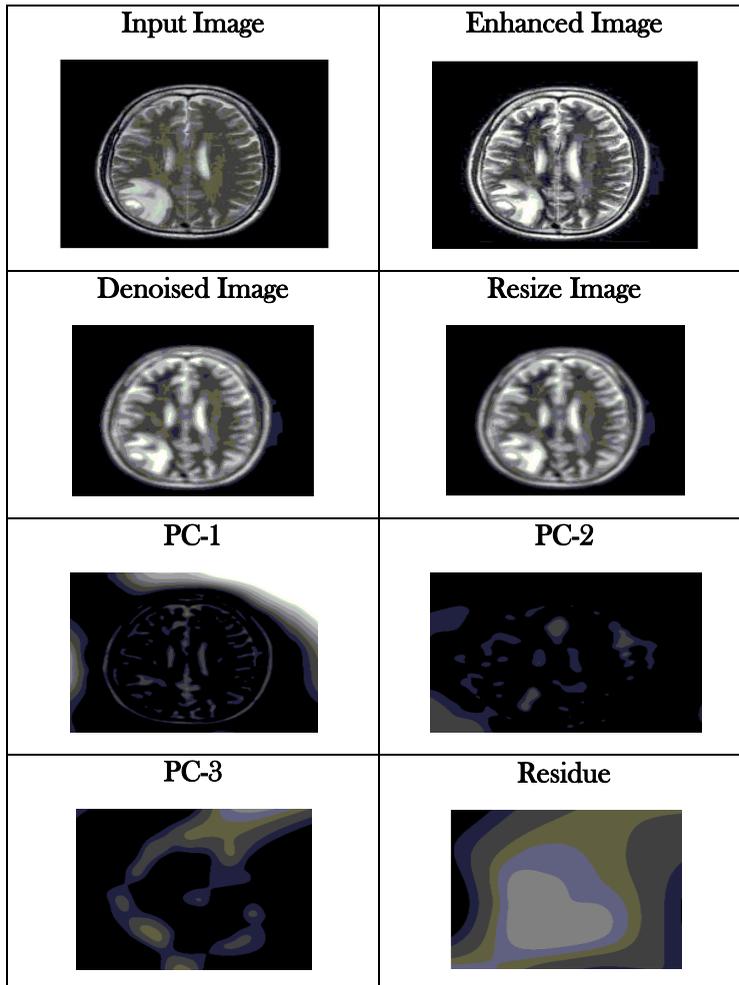


Figure 2. Result snaps of Hybrid coding algorithm using Oscillation & Quasi Fractal

4.1.1 Results of Hybrid Method for various brain images from hospitals

Table 1. Statistical parameters CR & PSNR

Image/Parameters	CR	PSNR
IMG-1	24.61	34.15
IMG-2	22.41	33.0985
IMG-3	20.69	41.4213

IMG-4	20.3	34.4859
IMG-5	21.78	37.7
IMG-6	20.17	41.6582
IMG-7	16.08	34.966
IMG-8	28.96	37.7
IMG-9	18.15	32.93
IMG-10	18.74	33.42
IMG-11	21.89	36.15299

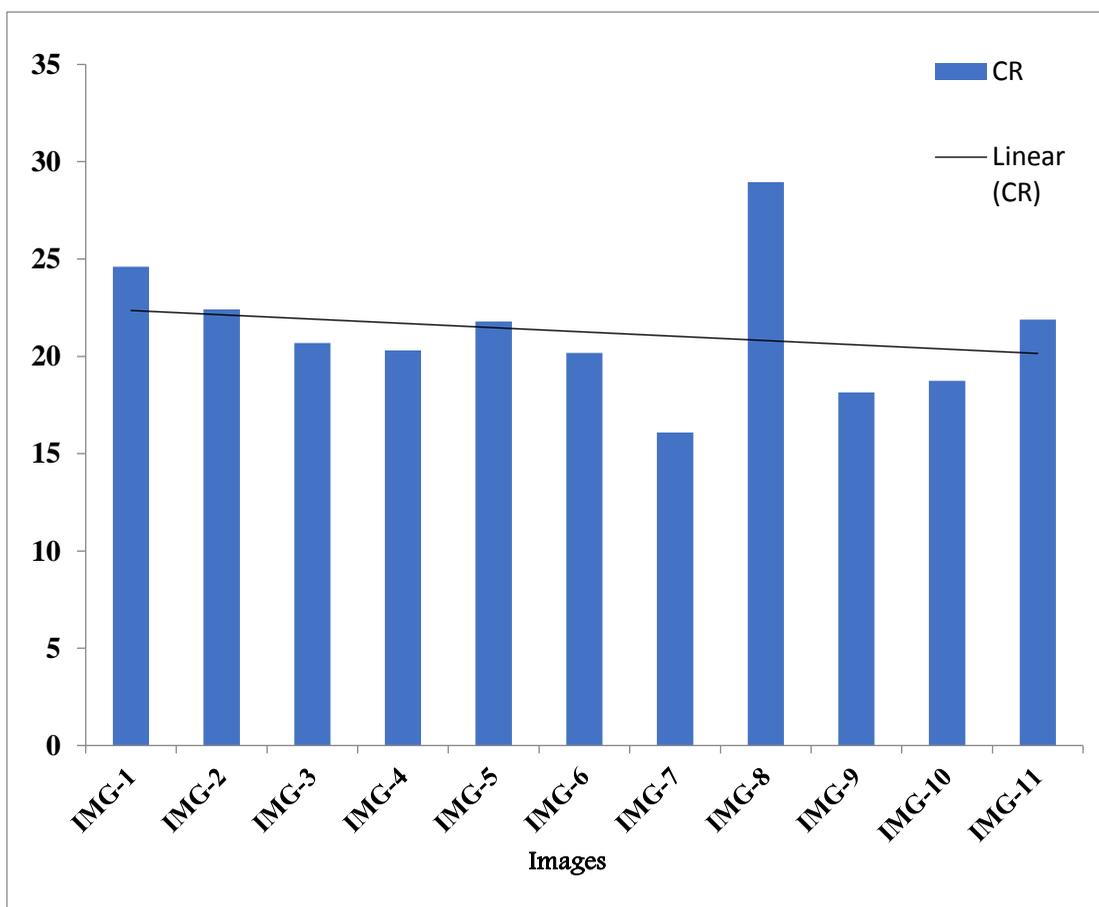


Figure 3. Analysis of CR for Various Brain Images using Hybrid Techniques

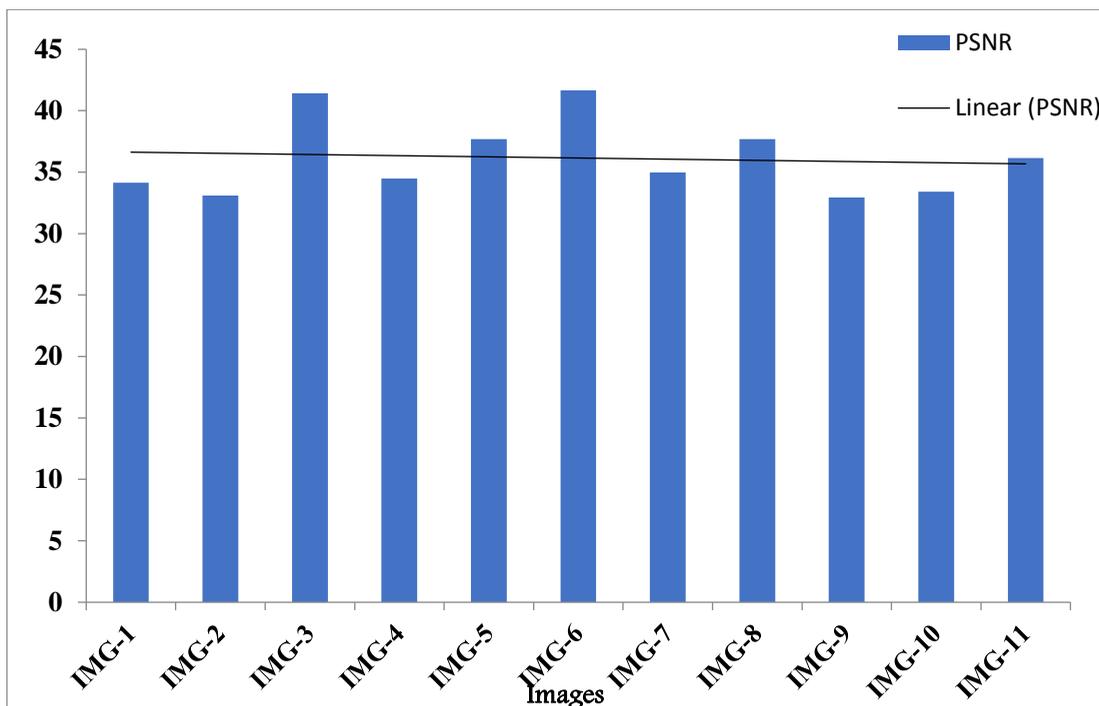


Figure 4. Analysis of PSNR for Various Brain Images using Hybrid Techniques

4.1.2 Results of Hybrid Method for CR & PSNR

Table 2. Statistical parameters CR & PSNR

Sr. No	Technique used for Image Compression	Parameters	
		CR	PSNR
1	Hybrid Coding using Oscillation Concept & Quasi Fractal	24.61	33.51
2	Hybrid Coding using BTC-SPIHT	5.65	33.01
3	Oscillation Concept Method with Enhancement	5.11	32.77
4	Oscillation Concept Method without Enhancement	4.32	32.56
5	Fractal	3.51	31.45
6	DWT	1.24	29.30
7	DCT	1.15	27.04
8	DFT	1.01	27.04

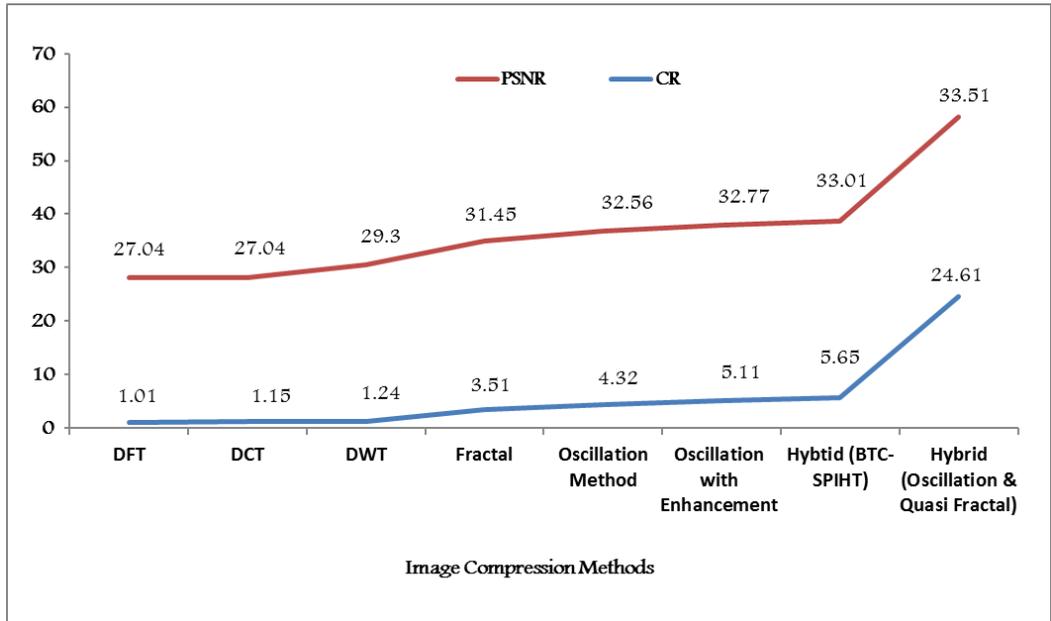


Figure 5. Statistical parameters CR & PSNR for various Image Compression Techniques

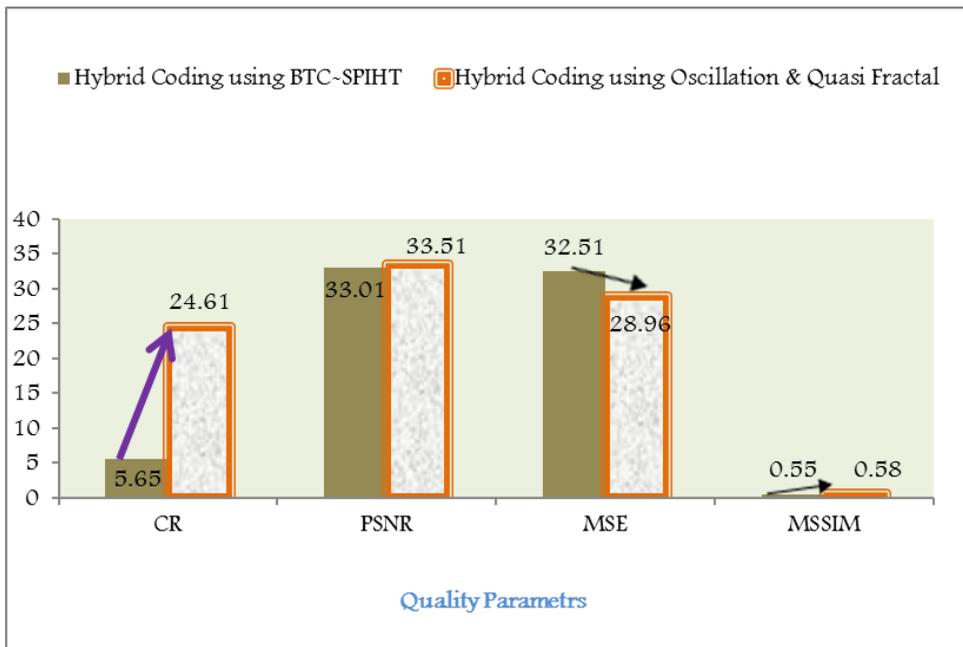


Figure 6. Comparative Analysis Between two hybrid methods (BTC-SPIHT & Hybrid Coding using Oscillation & Quasi Fractal)

5. Conclusion

On comparing the results of existing and proposed work it is found that the proposed image compression algorithm has given good results. The existing techniques like DFT, DCT, DWT and fractal have given compression ratio in the range between 1 to 4. On the other hand the proposed works have increased the compression ratio to the range between 1.01to to 24.61. Similarly the PSNR which is measuring quality for the existing algorithms is in the range between 27.04 to 33.51 whereas the proposed algorithms have improved the image quality which is comparatively very less proving that the proposed algorithm is providing better results.

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Acknowledgements: NIL

Conflict of interest: NIL

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