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Hybrid image compression technique using oscillation concept & quasi fractal

Satyawati S. Magar[1] · Bhavani Sridharan[1]

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Abstract

In medical images, especially for brain images ROI is very important for diagnosis. ROI is very important compare to other portion of an image. Here ROI is included in hybrid coding algorithm for effective image compression. Compression method gives better results using hybrid algorithm. In this paper, we have used hybrid compression method, Lossless used for ROI portion and for non-ROI portion the lossy compression techniques has been used. The experimental results shows that better Compression Ratio (CR) with acceptable PSNR has been achieved using hybrid technique based on Morphological band pass filter and Adaptive thresholding for ROI.

Keywords Morphological filter · Adaptive thresholding · Hybrid technique · Oscillation concept · BTC-SPIHT · ROI · Quasi-fractal

1 Introduction

In the field of Medical, compression is necessary for storing big data and data for diagnosis. For medical advancement many compression techniques where used. The goal is to achieve higher compression rate by keeping good quality of image. By applying separate techniques many times we are not able to get all parameters as per our requirements. Results show that the coding performance can be significantly improved by the hybrid algorithm. Here, Quasi fractal coding algorithm is applied on ROI & Oscillation concept method is applied on Non-ROI. Hybrid technique is based on Morphological band pass filter and Adaptive thresholding.

1.1 Oscillation concept

In this method we are focusing on oscillations in a input image. Appropriate oscillations can be utilized for image compression. We can achieve better CR by this method. We are going for number of iterations over the extracted part oscillation concept methodology extracts more part from an image. This process should continue till we are not getting good quality of an image. This entire method provides better level of an image compression [1–3]. Computational time has been calculated and it is 312 s.

1.2 Important steps of oscillation concept

It has been used as lossy compression technique and implemented on non-ROI of an image. For implementation steps used are as follows

a) Identify all local maxima of x (t).
b) Identify all local minima of x (t).
c) Interpolate between maxima ending up with some envelope call it e max (t).
d) Interpolate between minima ending up with some envelope called e min (t).
e) Extract 1st Principal component.
f) Continue the iterations, till we will get better quality of Principal component.

Here we have taken three no. of iterations [1, 2].

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* Satyawati S. Magar
magarss_123@rediffmail.com

Bhavani Sridharan
bhavanisns@yahoo.com

[1] Department of ECE, Karpagam Academy of Higher Education, Coimbatore, Tamilnadu, India

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2 Hybrid coding using BTC &SPIHT for compression of biomedical images

2.1 Decorrelation stretch (DCS)

The DCS is an image enhancement technique. Here DCS has been used as optimization technique. It is the process that is used to enhance (stretch) the color differences found in a color image. It enhance the separation of color i.e. R/G/B in images. This method is used for removing inter-channel correlation found in input pixels hence it is known as DCS. Sampled pixels are taken and nine sums that are needed to calculate the covariance matrix for the three channels are accumulated [4].

2.2 Contrast limited adaptive histogram equalization (CLAHE)

It is the modified or advanced version of AHE. Basically CLAHE is used for biomedical imaging. This algorithm was developed to prevent the over amplification of noise. It makes parts of images called tiles or into contextual regions and applies the histogram equalization to each one. It has used as optimization technique.

2.3 Block diagram for BTC-SPIHT

Block diagram of Hybrid coding using BTC-SPIHT is as shown in Fig. 1.

2.3.1 Block truncation encoding (BTC)

This technique is very simple and fast lossy Image Compression Technique for digitized gray scale images. For compressing digital gray level images BTC uses moment preserving quantization method. Even though this method retains the visual quality of the reconstructed image with good compression ratio and PSNR [5].

i) Mainly the Block truncation (BTC) algorithm divides into separate task that is,

a) Performing the Quantization. b) Coding the Quantization. c) Bit plan Reduction.

ii) Method used for BTC implementation:

Input image (M x N) → Construct (n x n)→ Sub-images→ Quantizer→Symbol encoder →Compressed image.

2.3.2 Set partitioning in hierarchical trees (SPIHT)

This is one of the most powerful wavelet based image compression techniques, hence it is used as lossless image compression method. The main advantages of SPIHT method is, it can provide good Image quality with high PSNR and it is the best method for progressive Image compression.

Advantages Simple quantization algorithm, Fast coding/decoding, Completely adaptive, Lossless compression. SPIHT algorithm is represented by following mathematical equation [6, 7].

Hence SPIHT has been chosen for image compression of biomedical images.

$$In(T) = \begin{cases} 1; & \max_{(i,j)\in T}\{|C_{i,j}|\} \geq 2^n \\ 0; & \text{otherwise} \end{cases}$$

In (*T*), is the importance of a set of coordinate T.

Ci,, is the coefficient value at each coordinate (i, j).

The complete SPIHT algorithm does compression in three steps such as.

Sorting→ Refinement→ Quantization.

3 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. Application of fractal compression to medical images would

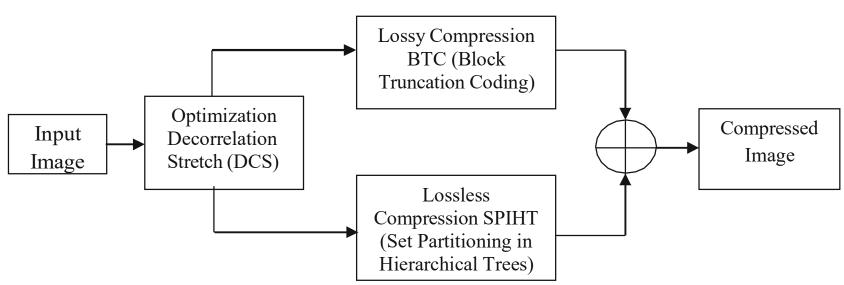


Fig. 1 Hybrid coding technique BTC-SPIHT

allow much higher compression ratio with good picture quality. In this paper Quasi lossless fractal coding is used. It is lossless method used for ROI which achieves better results of all quality parameters [8–11].

4 Methodology

4.1 Flow diagram for hybrid technique using oscillation concept method & quasi fractal

Hybrid techniques for compression of an image are as follows in Fig. 2: [3, 12, 13].

Key factors of innovative hybrid method are morphological filter & adaptive threshold. This methodology is totally based on multilevel operation. By using this methodology we can achieve required ROI. [14]

4.2 System flow diagram for hybrid techniques (Fig. 3)

4.3 Morphological filters

It can be defined as the multilevel open operations. Since the multilevel open operation is just like a lowpass filter, it eliminates those structures of the image that are smaller than structure element. A morphological Band-Pass filter is defined as the difference of two multilevel open operations with two different structuring elements. Morphological band-pass filter (MBF) is introduced to detect micro-calcifications, which is implemented by opening the original image two times with two different structure elements respectively, and subtracting one opened image using another one that can decompose the image into interest details domain image where micro-calcifications tend to appear. MBF's are tuned for the detection task, and binary image containing ROI are obtained.

Morphological filters have been used to find region of interest (ROI), also it gives better results that DWT [15, 16].

We have to take multilevel morphological operations which are defined as algebraic operations. These algebraic operations used concept of umbra (U[]) and top (T[](surface.

The multilevel expansion of function f by a multilevel structuring element s is denoted by

$$\oplus s = T[U[f]\oplus U[s]] \quad (1)$$

By this definition, it can be computed in terms of a maximum operation and a set of addition operations.

$$(f \oplus s)(x) = \max[f(x-z) + s(z)] \text{ for all } z \in s \text{ and } x - \in zf \quad (2)$$

Where, F and S is the domain of functions f and s, respectively.

The multilevel erosion of a function f by a multilevel structuring element s is defined by

$$f \Theta s) = [TUf \Theta U[s]] \quad (3)$$

Using the above definition, the erosion can be evaluated in terms of a minimum operation and a set of subtraction operations.

$$(f \Theta s x) = +\min[f(xz) - s(z)] \text{ for all } z \in s \text{ and } x + \in zf \quad (4)$$

Multilevel open is implemented by first erosion and then dilation using the same structure. It is defined

$$A:B = (A \Theta B) \oplus B \quad (5)$$

4.3.1 Dilation & Erosion in morphological filter

Due to morphological filter we can refine the compression process, Also Morphological band-pass filter (MBF) is introduced to detect micro-calcifications. Due to grouping of microcalcifications suggests that tumor may be present in

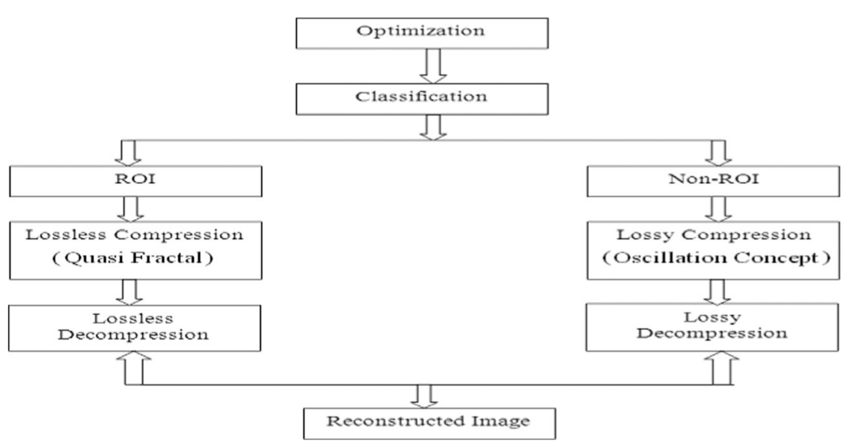
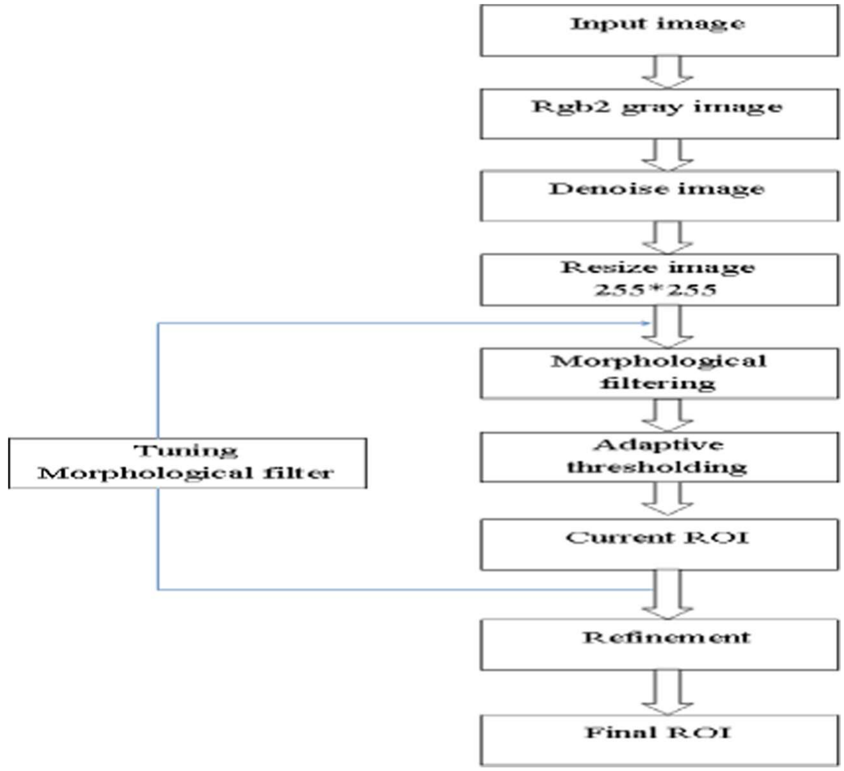


Fig. 2 Flow diagram of hybrid technique

Fig. 3 Methodology of ROI



the organ. Dilation adds pixels to the boundaries of object in an image while erosion removes pixel on object boundaries.

4.4 Adaptive threshold

In image processing one of the 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 subimages and utilize global thresholding techniques for each subimage [15, 17].

4.4.1 Procedure for adaptive threshold

i. To divide an image into sub images.
ii. To test for bimodality for each sub image.
iii. To apply excellent Global Thresholding for each identified image with bimodal histogram [17].

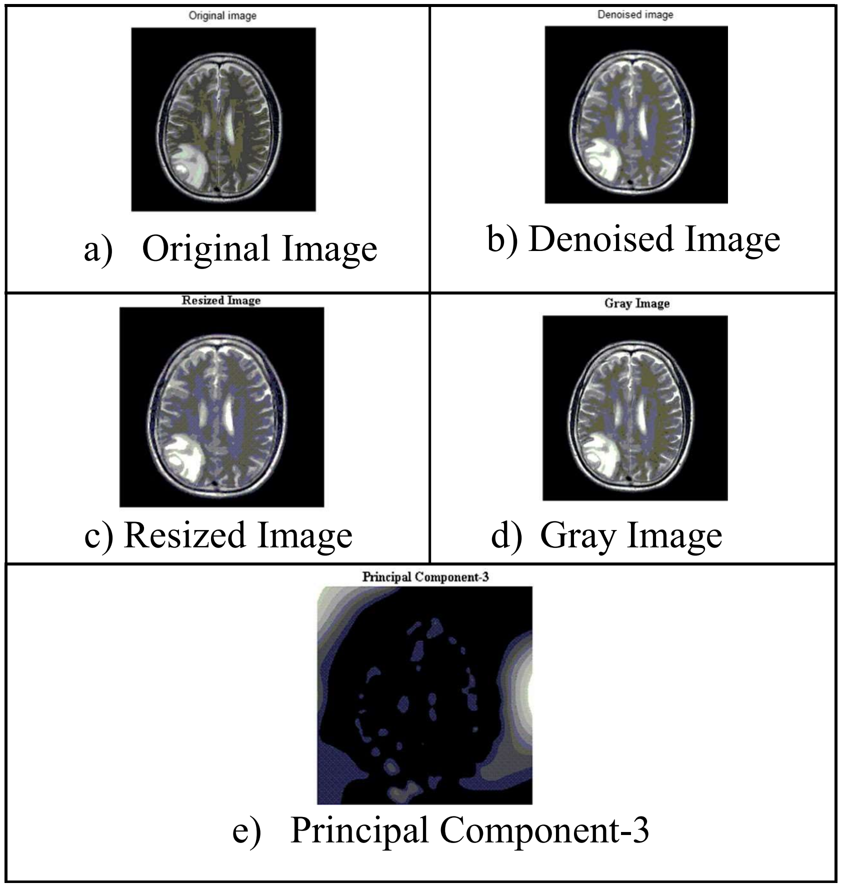
4.4.2 To calculate the threshold (*T(x, y)*)

i. To select b x b region around the pixel location, b is selected by the user.
ii. Open Computer Vision library provides 2 methods to calculate this weighted Average (WA).
iii. We can either use the average of all the pixel location that lies in the b x b box or we can use a Gaussian weighted average of the pixel values that lies in the box.
iv. In the latter case, the pixel values that are near to the centre of the box, will have higher weight. We will represent this value by *WA(x, y)*.
v. Threshold value *T(x, y)* by subtracting a constant parameter, let's name it param1 from the weighted average value *WA(x, y)* calculated for each pixel in previous step.
vi. The threshold value T(x, y) at pixel location *(x, y)* is then calculated using the formula given as *T(x, y) = WA(x, y) - param1* [15, 17]

4.5 Implementation of another hybrid algorithm/method

By using this hybrid technique (Quasi fractal & Oscillation method) we have achieved better results than Hybrid method (BTC & SPIHT). Firstly, we have implemented Hybrid method using BTC & SPIHT but not achieved the CR & PSNR results that much improved compared to many hybrid algorithms implemented by researchers. Hence, we concluded and implemented another hybrid algorithm using Quasi fractal & Oscillation method.

Fig. 4 Simulation Results of Hybrid Techniques



4.6 Proposed algorithm for hybrid image compression technique using Oscillation Concept & Quasi Fractal

i. Read Input Image.
ii. Convert RGB to Gray image.
iii. Denoise an image. (To remove the noise and to make it more smoother)
iv. Resize image into 256* 256.
v. Filtration by using Morphological Filters.
vi. Apply Adaptive thresholding.
vii. Find current ROI.
viii. Repeat procedure by tuning morphological filter for Refinement.
ix. Find Final ROI.
x. Find ROI.
xi. Apply Lossy Compression Technique over final Non ROI.
xii. Apply Lossless Compression Technique on ROI.
xiii. Combine O/P images of xi & xii.
xiv. Show reconstructed compressed image.

Table 1 Quality Parameters

Sr. No	Technique used for Image Compression	Parameters			
		CR	PSNR	MSE	MSSIM
1.	Hybrid Coding using Oscillation Concept & Quasi Fractal	24.61	33.51	28.96	0.58
2.	Hybrid Coding using BTC-SPIHT	5.65	33.01	32.51	0.55
3.	Oscillation Concept Method with Optimization	5.11	32.77	34.34	0.54
4.	Oscillation Concept Method without Optimization	4.32	32.56	36.06	0.53
5.	Fractal	3.51	31.45	46.47	0.50
6.	DWT	1.24	29.30	76.35	0.32
7.	DCT	1.15	27.04	128.3	0.24
8.	DFT	1.01	27.04	128.3	0.23

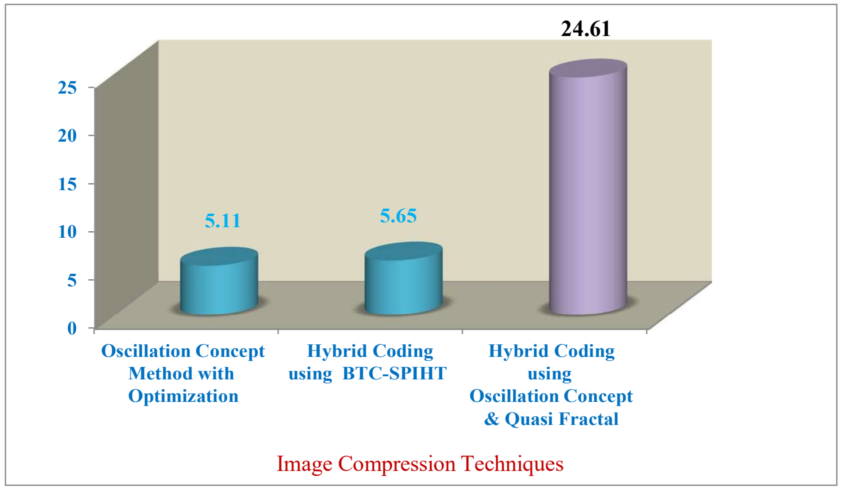


Fig. 5 Graphical representaion of CR

4.7 Quality parameters

1) Compression Ratio (CR): A compression ratio is the average number of bits per pixel (bpp) before compression divided by the number of bits per pixel after compression, it means the ratio of size of original image to the size of compressed image.

$$CR = \frac{\text{Size of Input Image}}{\text{Size of output Image}}$$

2) Peak signal to Noise Ratio (PSNR): It is generally used to analyse quality of image, sound and video files in dB (decibels).

$$PSNR = 10 * \log_{10} \frac{255^2}{MSE}$$

Where, MSE: Mean Square Error.

3) Mean-Square Error (MSE): The MSE represents the cumulative squared error between the compressed and the original image.

$$MSE = \sum_{i=1}^{x} \sum_{j=1}^{y} \frac{(Aij - Bij)^2}{x * y}$$

4) Mean Structural Similarity Index (MSSIM): Mean SSIM index to evaluate the overall image quality.

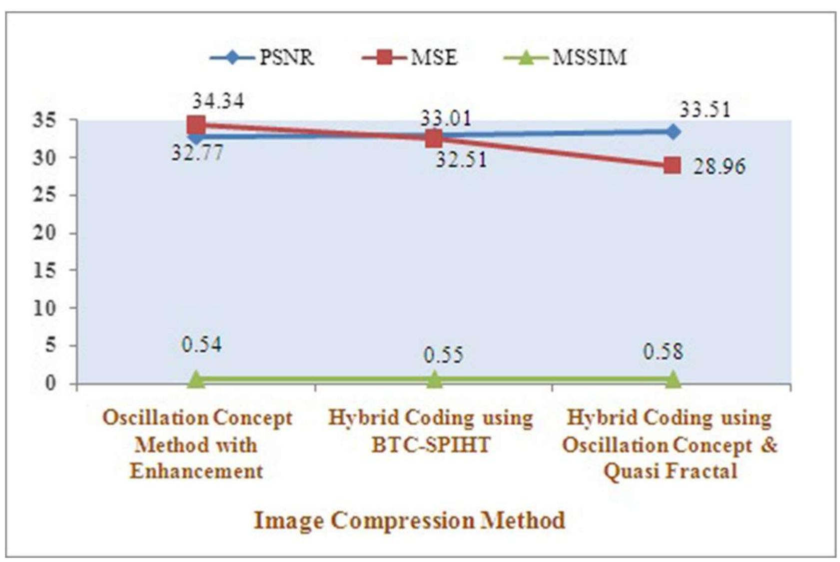


Fig. 6 Graphical representaion of various quality parameters

$$MSSIM = \frac{1}{M} \cdot \sum_{j=1}^{M} SSIM(Xj; Yj)$$

5 Results and discussions

For getting good results hybrid method has been used, especially morphological filters &adaptive threshold techniques used and achieved better CR than Oscillation concept with optimization and hybrid technique using BTC &SPIHT for compression of Biomedical Images. Also achieved good PSNR value Simulation result snaps of hybrid image compression technique are as shown in Fig. 4. [18]

Comparison of quality parameters are as shown in Table 1.

5.1 Comparative analysis of CR using graphical representation

Graphical representation of compression ratio (CR) for proposed method & also for two hybrid methods is as shown in Fig. 5. It is observed that CR is continuously increasing in each method. In proposed method it is 5.11. In BTC-SPIHT hybrid coding technique, it is slightly increased i.e. 5.65, but in hybrid coding technique using proposed method & quasi fractal method,it is highly improved i.e. 24.61.

5.2 Comparative analysis of PSNR,MSSIM,MSE using graphical representation

Graphical representation of various quality parameters like PSNR,MSSIM & MSE is as shown in Fig. 6. It is observed that as PSNR increases and MSE decreases. Better the value of PSNR, better is the quality of image. In proposed method value of PSNR is 32.77. The PSNR of proposed system is 33.51 db which is practically and theoretically very good. Mean square error is less and ultimately PSNR is high. In proposed method Output image does not make resemblance with input image as it is focused on abrupt changes only. Despite of this fact PSNR is around 33.51db which is enough to prove effectiveness of proposed method, it means quality of image is also maintained.

6 Conclusion

In this paper, hybrid method is used for compression of brain images. Hybrid concept is implemented using morphological filter & adaptive threshold. Here, Hybrid Image compression technique using Oscillation concept & Quasi Fractal gives the Compression Ratio 24.61 which improve a lot than Hybrid Coding using BTC-SPIHT and oscillation concept method with optimization which are 5.65& 5.11 respectively. Especially PSNR is also retain and bit improved i.e. 33.51. This hybrid technique improves results competently.

Compliance with ethical standards

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Conflict of interest None of the author received fund from any agencies or committee or organization.

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