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# An Efficient Region of Interest-Based Hybrid Compression Technique for Medical Images

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**Abstract** Medical images modalities are extensively adapted to diagnosis disease. These imaging modalities include computed tomography (CT), magnetic resonance imaging (MRI), ultrasound (US), and X-ray... etc. The problem associated with medical images is the storage space and bandwidth required for archiving and transmission of this kind of images. Thus image compression is a key factor to reduce the bit rate for transmission or storage while maintaining an acceptable reproduction quality. In this paper, an efficient ROI compression approach using hybrid lossy-lossless compression will be presented. This method is based on applying discreet wavelet transform (DWT) as a lossy method and grayscale and binary matrix (GSBM) coding algorithm as lossless method. The results show that the proposed method performs much better than Jpeg-lossless especially with smaller regions of interest.

**Keywords:** DWT, ROI, Image Compression, Medical Image.

# طريقة هجينة فعالة لضغط الاجزاء المهمة في الصور الطبية

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**الملخص** تعتبرالصور الطبية من الطرق الشائعة الاستخدام لتشخيص الامراض. تشمل هذه الصور صور المقطعية الحاسوبية وصور الرنين المغناطيسي وصور الموجات فوق الصوتية وصور اشعة اكس. تعتبركمية البيانات في الصور الطبية كبيرة جدا وبالتالي فانها تحتاج الى مساحة وسرعة عالية لتخزينها او ارسالها وعليه فان عملية ضغط تلك الصور يعتبر الحل الامثل لتقليل حجمها وزيادة سرعة ارسالها. في هذه الورقة تم اقتراح طريقة هجينة لضغط بيانات الصور الطبية باستخدام الضغط بدون فقد والضغط بفقد للاجزاء المهمة والاجزاء الغير مهمة على التوالي. هذه الطريقة تعتمد على استخدام محول المويجة المتقطع لضغط بيانات الصورة بفقد و مصفوفتى التدرج الرمادى والثنائية للضغط بدون فقد. النتائج المتحصل عليها تثيت ان الطريقة المقترحة افضل من بعض الطرق الاخرى في حالة الاجزاء ذات الاهمية صغيرة الحجم.

**الكلمات المفتاحية:** محول المويجة المتقطع ، الاجزاء ذات الاهمية ، ضغط الصور ، الصور لطبية.

## I.INTRODUCTION:

visual inspection of medical images is an important task in diagnosis that demands experience and great concentration. The rapid advancement in digital image processing has led to computer assisted diagnosis (CAD) [3, 4]. Even the CAD is used for diagnosis purposes, still medical images have to be in a compressed form. Image communication systems for medical images have bandwidth and image size constraints that result in time-consuming transmission of uncompressed raw image data. Thus image compression is a key factor to improve transmission speed and storage, but it risks losing relevant medical information [5]. It exploits common characteristics of most images that are the neighboring picture elements or pixels are highly correlated [6]. It means a typical still image contains a large amount of spatial redundancy in plain areas where adjacent pixels have almost the same values. Image compression techniques can be classified into two different categories; lossy and lossless. Lossless compression allows for the perfect reconstruction of the original images, but yields small compression ratios around 3:1 even under state of the art coding methods. [7]. On the other hand, significantly higher compression ratios can be obtained if the loss of quality can be allowed, thus; more compression is obtained at expense of higher image degradation, which may cause misdiagnosis. However, a hybrid lossy-lossless compression technique can be applied on different regions of the image. Since only a small portion of the image might be diagnostically useful (ROI), this region can be lossless compressed while athe rest is lossy compressed. In this paper, an efficient hybrid lossy-lossless compression technique has been proposed. Our new lossless algorithm used as lossless technique for ROI[1,2], while a lossy wavelet-based compression is used as lossy technique for the rest of image regions. More details on this technique will be explained in the next section.

**II.MATERIALS AND METHODSA:** region of interest (ROI) is defined as the area of an image which is clinically or diagnostically important to doctors who can free to identify the ROI based on their needs. In this study a sample of 8-bit per pixel grayscale images have been used. The original images are shown in figure 1. These images are first read then a region of interest is chosen and extracted. There are two methods to identify the ROI, one is manual and the other is automatic. The manual method was used in our case to identify the ROI of 10% and 15% size. The ROI has been losslessly compressed whereas the remaining image was lossy compressed. The following figures show some of compressed images, where the GSBM algorithm proposed in [1,2] was used as a lossless technique to compress ROI, while the DWT was used as a lossy technique to compress the remaining image. The general block diagram of the proposed method is illustrated in figure 2.

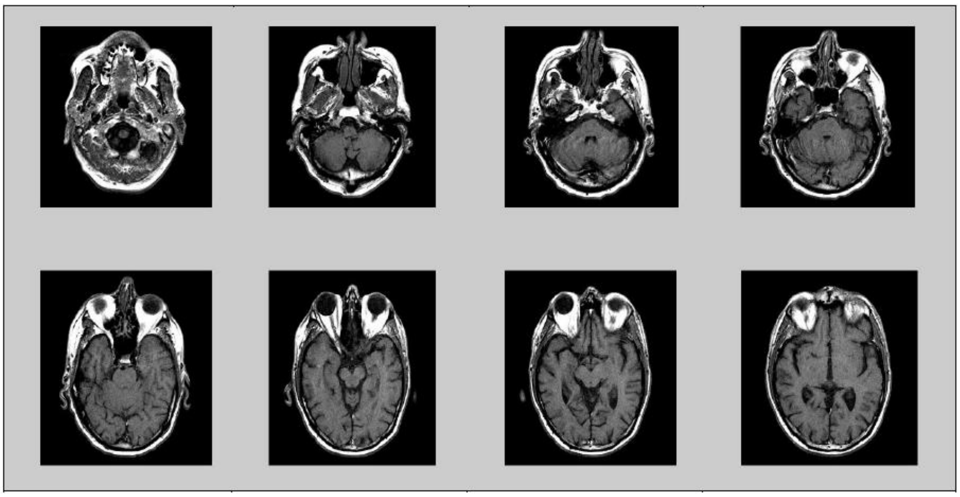

**Figure 1:** Original Test Images

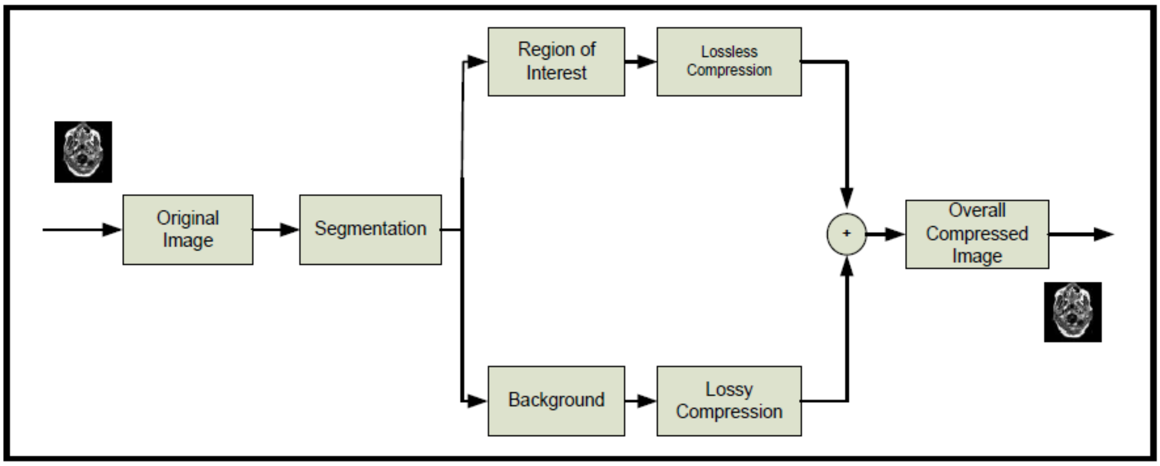


**Figure 2:** General Block Diagram of Proposed Method

**Table 1 Steps of the Proposed Method**

1:// start
2:// Read the original image
3// Segment the image into ROI and BG subimages
4:// Segmentation Process
5:// Select the coordinates of the ROI subimage
6:// if the selected coordinates are correct
Extract the (ROI)
7:// else goto 5
8:// For the (ROI) subimage
Apply the lossless algorithm [1]
9:// for the rest of mage
Apply lossy compression using WT

Our proposed lossless algorithm is based on only two matrices, binary matrix and grayscale matrix, that's why is called GSBM The main steps of the proposed algorithm are as follows:

***STEP1***: Read the original image matrix [OR].

***STEP2***: Construct the binary matrix [BM] and grayscale matrix [GSM] based on the following steps.

***STEP3***: Compare each pixel in the matrix [OR] with the previous pixel in the same matrix as indicated in figure 3.

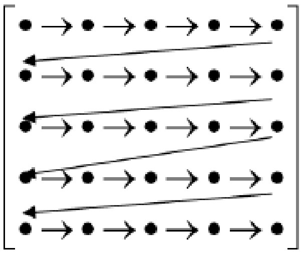

**Figure 3:** Original image pixels comparison

***STEP4***: The binary matrix elements are calculated as follows:

$$[BM]_{i,j} = \begin{bmatrix} 0 & if & [OR]_{i,j} = [OR]_{i,j+1} \\ 1 & otherwise & \end{bmatrix}$$

(1)

***STEP5***: First element in [GSM] is set to be equal to the value of the first pixel of [OR]

***STEP6***: The rest of the elements of [GSM] are calculated as follows:

$$[GSM]_k = \begin{bmatrix} nul & if & [OR]_{i,j} = [OR]_{i,j+1} \\ [OR]_{i,j} & otherwise & \end{bmatrix}$$

(2)

Note that [BM] is a 2-D matrix while [GSM] is a 1-D matrix.

***STEP7***: The original image can be reconstructed as follows:

$$[rec\_img]_{i,j} = \begin{bmatrix} [GSM]_k & if & [BM]_{i,j} = 0 \\ [GSM]_{k+1} & if & [BM]_{i,j} = 1 \end{bmatrix}$$

(3)

The quality of the compressed image is measured using Peak Signal-to-Noise Ratio (PSNR), based on the Mean Square Error of the reconstructed image. The formula for PSNR calculation is given by [8,9]:

$$PSNR = 20\log\left(\frac{2^B - 1}{MSE}\right) \text{dB}$$

(4)

Where B is the bit depth of the image. For an 8-bit image, the PSNR is computed by [8,9]::

$$PSNR = 10\log\left(\frac{(255)^2}{MSE}\right) \text{dB}$$

(5)

*MSE* is the Mean Square Error and it can be calculated using the following formula [8,9]::

$$MSE = \frac{1}{NM}\sum_{1=0}^{N-1}\sum_{j=0}^{M-1}\left[\left|f(i,j) - f^*(i,j)\right|^2\right]$$

(6)

**III.RESULTS AND DISCUSSION:** The proposed method algorithm is explained in table 1. A sample of four 8-bit grayscale images has been used in this study. Each image is broken down into two subimages (ROI and BG). The ROI size has been chosen to represent 10% and 15% of the original image. The ROI is processed using our proposed lossless coding algorithm [1, 2], while the rest of the image is lossy compressed using discrete wavelet transform. Figure 4 shows the original image, ROI subimage, background subimage and the overall reconstructed image.

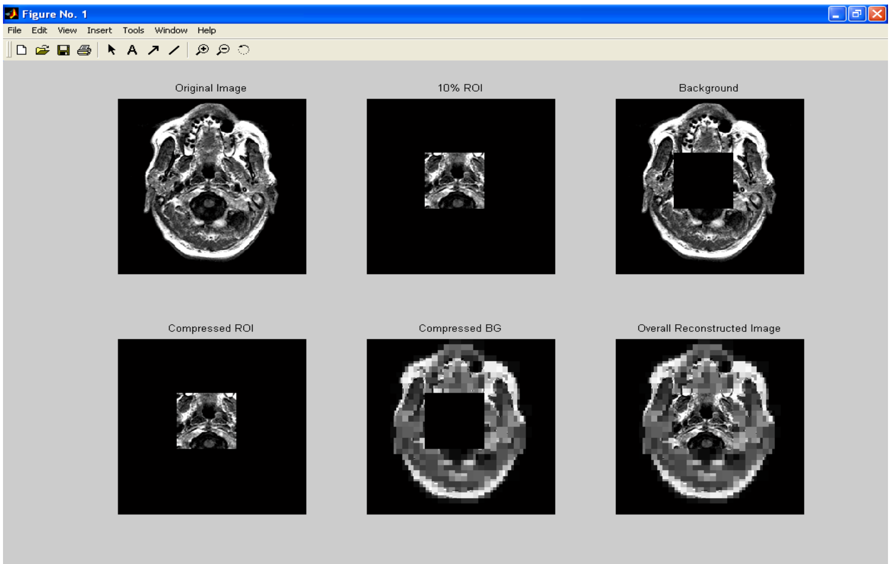


**Figure 4:** shows the original image and its 10% ROI

A comparison between different backgrounds, ROI's and the overall images (Background and ROI) in terms of the qualities which measured by Peak Signal to Noise Ratio (PSNR) is represented in a graph which plotted in figure 5.From this figure, If we compare the quality of the compressed image with respect to ROI size, I t can be noticed that smaller ROI size can be compressed more efficiently. This is because of the correlation between neighboring pixels becomes higher in small regions than bigger one's. The performance of the proposed technique is compared with other research results. The results comparisons are indicated in Table 2 which shows that the proposed technique performance is similar or better than other techniques.

**IV.CONCLUSION:** In this paper, ROI based lossy-lossless hybrid compression technique is presented. Different ROI's sizes are extracted in which the pixels in the ROI's have been replaced by zeros. The ROI is losslessly compressed using our proposed algorithms [1,2].while the rest of the image is lossy compressed with high compression ratio using discrete wavelet transform. The advantage of the proposed method comes from its simplicity and efficiency compared with existing methods.

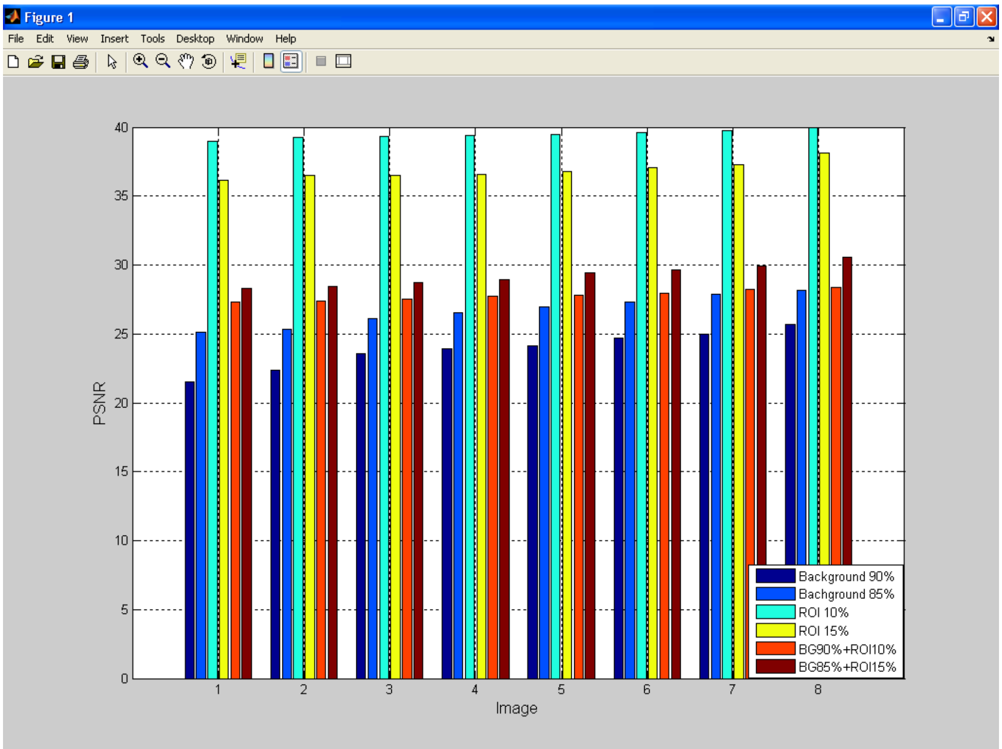


**Figure 5:** The PSNR of different ROI and backgrounds

**Table 2 Performance comparison of the proposed ROI technique**

| Method | Technique | ROI size | Performance |
|---|---|---|---|
| Zhang & Wu Method [10.] | WT , JEPG2000 | 10% & 15% | 12:1-18:1 |
| Belc & Foo Method [11] | WT , HC | 10% | 14:1 – 38:1 |
| Chan Method [12] | WT, Modified JPEG2000 | 10% | 12:1 – 25:1 |
| Christopolos Method [13] | WT, Maxshift algorithm | 8% - 25% | 16:1 – 50:1 |
| Proposed Method | WT, GSBM proposed algorithm. | 10% & 15% | 16:1 – 48:1 |

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