ISSN : 2394-2975 (Online)
ISSN : 2394-6814 (Print)

Efficient Lossless Medical Image Compression Algorithm Implementation Using IMWT

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Abstract

In this communication era, image compression is one of the demanding fields. In biomedical engineering, analyzing and compressing the medical image is an important aspect. Analyzing the medical image and compressing the data are rapidly evolving fields, with greatly increasing applications in biomedicine, teleradiology, telemedicine and medical data analysis. From wavelet theory, it is well known that multiwavelets perform better compared to any other wavelets in the field of image processing. A competent compression and coding performance based on integer multiwavelet transform (IMWT) using OMP algorithm is discussed in this paper. On wavelet basis, expanding the signal gives transformed coefficients. The same underlying data is represented in different way in the transformed signal. It is an efficient way of representation because the original information having a relevant part is represented in a relatively small number of coefficients. The anticipated algorithm gives enhanced results, which is proved experimentally. This paper discusses a coding technique which is suitable for progressive transmission. The resulting image has better performance parameters such as PSNR (peak signal to noise ratio), MSE (mean square error) and SSIM (structural similarity index).

Keywords

Wavelet transforms Multiwavelet, IMWT, Wavelet theory, PSNR, MSE, and SSIM

I. Introduction

Information can be represented in a compact form, which is an art or science called image compression. By using it the number of bits can be reduced, required to represent an image or a sequence of video. Algorithm for compression takes an X input and produces information that is compressed so that it takes fewer bits for storage and transmission [1]. The algorithm for decompression regenerates the information which is compressed and gives original image.
The algorithm for compression can be categorized into two types based on the techniques of reconstruction as lossy and lossless compression [4]. In lossy compression, there is a loss and missed information which is bearable. This type of compression is used in DVDs. The image is not retrieved completely. Conversely, in lossless compression the complete information can be retrieved accurately without any loss. Finds it application in medical imagery where a small difference cannot be accepted between original and regenerated information [5]. Examples: Bit plane coding, Huffman coding etc.
MSE: The difference between the reconstructed image and the original image is called Distortion. It is denoted by using Mean Square Error (MSE) in dB.

$$MSE=\frac{1}{NXN}\sum_{i=0}^{NXN}((Xi-Yi)(Xi-Yi))$$

PSNR: Fidelity or quality defines the similarity between the reconstructed image and the original image. It is measured using Peak Signal to Noise Ratio (PSNR) in dB.

$$\textbf{PSNR}=10\log_{10}(255^2/\textbf{MSE})\ \textbf{dB}$$

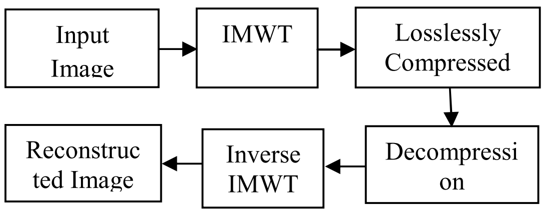
II. Agenda of Proposed Method

A. Existing Method

ROI is a significant characteristic given by the JPEG 2000 standard. The complete image is encoded by heterogeneous fidelity constraints as a single entity. This new method increases the complexity of algorithm but reduces the coefficients of the background. The resulting image has improved quality compared to scalar wavelet.

B. Proposed Method

Use of Integer multiwavelet transform is done for compressing the image in the proposed method and transform coefficients are losslessly compressed. By using multiwavelet transform, decomposition of compressed image is obtained. Maximum value of image pixel is used for encoding.



Decoding, decompression and reconstruction of the original image is done at the receiver side. One of the main advantages of this proposed method is that it has reduced MSE compared to other wavelet transforms and SSIM is increased.
DWT is used for analyzing both functional and numerical methodologies. For the applications in image processing, wavelets of two dimensions are used. The main advantage of DWT is temporal resonance. In the field of processing medical image, enhancement of image contrast is essential. Large coefficients are made larger and small coefficients are made smaller.
In wavelet decomposition, the image is split into many sub bands (LL, LH, HL, and HH). Only LL sub band is used for further decomposition because it has low noise and frequency compared to other sub bands.

III. Wavelet and Integer Wavelet Transform

In the field of image compression, the latest developments are techniques based on wavelets. It gives capability of multiresolution which cannot be obtained from any other methods. Generally, the wavelet transform produces floating point coefficients. Even though the use of these coefficients reconstructs an original image perfectly in theory, but the use of quantization and finite precision arithmetic results in a lossy scheme. The dilates and translates, of a single mother wavelet, are called first generation wavelets.

Construction of these is done using Fourier techniques. And to obtain the inverse transform, the operation of forward transform is reversed and addition is replaced with subtraction.

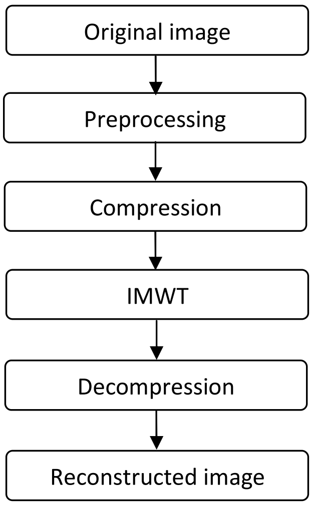
IV. Multiwavelet Transforms

Multiwavelets are defined using wavelets with scaling functions. But, several scaling and wavelet functions can be used to implement transform of integer multiwavelets. So the transform is helpful for multilevel decomposition. There are some advantages of integer multiwavelets over other multiwavelets, such as symmetry, orthogonality, and approximation are known to be significant in the domain of image processing. Multiwavelets are very much similar to integer multiwavelets with some vital differences.

In particular, multiwavelets are associated to both wavelet and scaling functions whereas depending up on applications integer multiwavelets have two or more wavelet and scaling functions. The wavelet coefficients actually depend up on down sampling process and filtering. Using addition and shift operations, the integer multiwavelet transform can be implemented efficiently. And also integer

Multiwavelet transforms increase dynamic range of the coefficients and higher order approximation.

V. Flowchart for Proposed Method



Steps Included The Process:

Step 1: Considering the original image

First the input image is fed to the system, it may be a highly non stationary one, so the size is converted to 256 x 256. If the image is color image, it is converted to gray scale by gray scale coding using RGB converter.

Step 2: Pre-Processing

In this step, each neighboring pixel of the input image has a new brightness value compared to output image. Such operation is known as filtration. There are many types such as image compression to remove redundancy, image restoration, image enhancement to highlight the shape, etc.

Step 3: Compression technique

Mainly compression techniques are of two types, lossy and lossless compression, which find application in digital image and video. DCT, vector quantization and Huffman coding are examples of lossy compression methods. Run length coding and LZW are examples of lossless compression coding. This paper proposes a method of lossy compression scheme rather than lossless compression scheme. As lossy compression scheme gives better compression ratio.

Step 4: Integer multiwavelet transform (IMWT)

In this step the compressed image is decomposed using IMWT. On wavelet basis expanding the signal gives transformed coefficients. The same underlying data is represented in different way in the transformed signal. Based on multi scalar function, the integer implementation of multiwavelet system is proposed by the IMWT.

Step 5: Decompressed image

In the decompression process, inverse of IMWT is applied. And decoding is done to extract the original image from the encoded bit stream.

VI. Results

The original image is used as test image. The image is resized and input image is of size 128x128. The project is implemented using graphical user interface (GUI) in Matlab simulation tool. Various medical images in jpeg format were used for verification and testing.

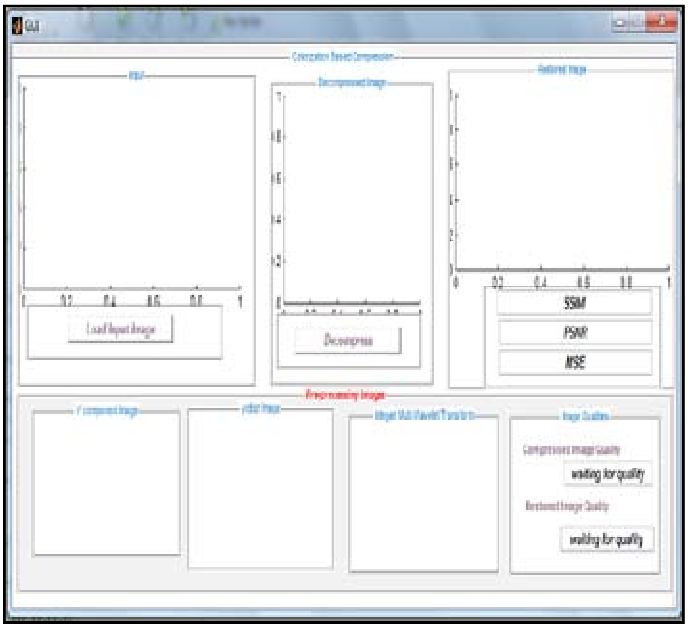


Fig 1: GUI for proposed method without any input

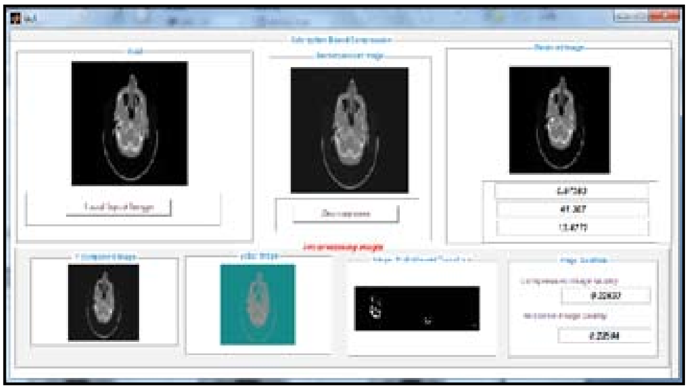


Fig 2: Output after loading CT scan of brain as input image.

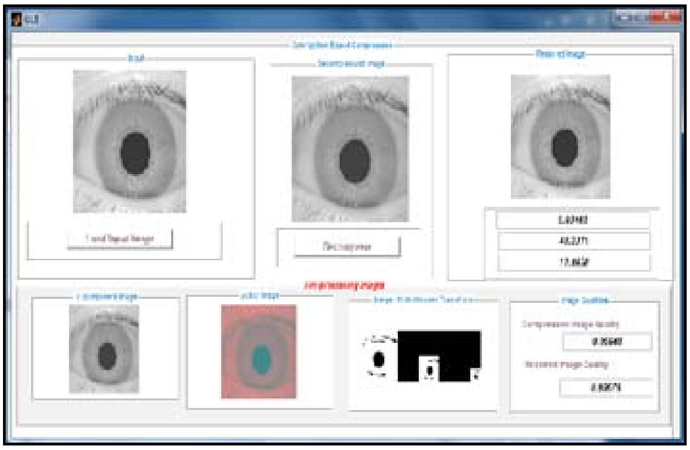


Fig 3: Output after loading input image of an eye

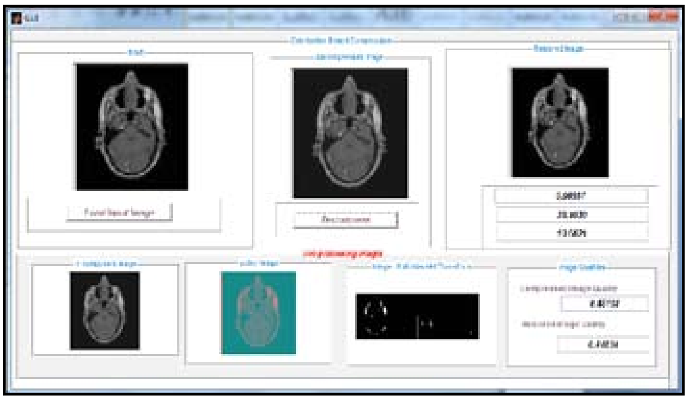


Fig 4: Output after loading CT scan of brain as input image.

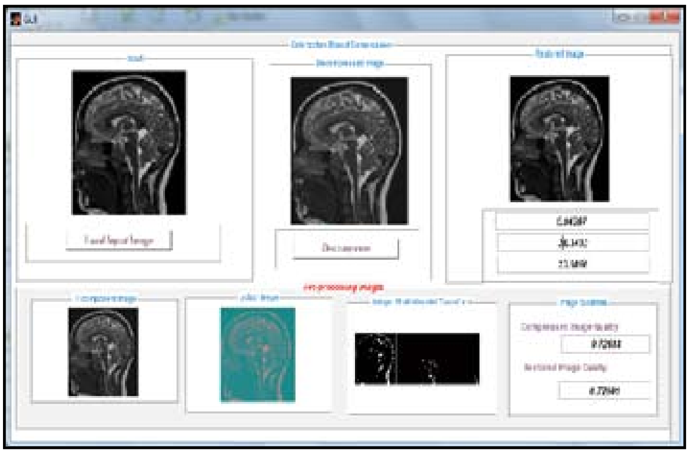


Fig 5: Output after loading CT scan of brain as input image.

Table 1: Performance metric measurements

S.No	Technical Parameter	Existing Technique	Proposed Technique
1	PSNR(dB)	37.32	41.39
2	MSE(dB)	57.50	13.43

VII. Conclusion

In this paper the focus is on the implementation of integer multiwavelet transform. It is proved experimentally that improved results can be obtained by exploiting the IMWT in proper way. This method is more suitable in telemedicine applications where transmission of medical images is done. It is due to usage of multiwavelet that a better result is obtained. It has less computational complexity and better coding efficiency.

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