Hybrid Medical Image Compression Method Using SPIHT Algorithm and Haar Wavelet Transform

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Abstract— CT or MRI Medical imaging produces digital form of human body pictures. There exists a need for compression of these images for storage and communication purposes. Current compression schemes provide a very high compression rate with a considerable loss of quality. In medicine, it is necessary to have high image quality in region of interest, i.e. diagnostically important regions. So, ROI part can be compressed with the help of the Lossless compression whereas Non Region of interest part can be compressed with help of Lossy compression as it is of lesser importance for diagnosis. In this paper Region of interest part is extracted with the help of thresholding method of segmentation and compressed with the help of SPIHT Algorithm thus producing a good quality image. And NROI part is compressed with the help of Haar wavelet transform. Our algorithm provides better PSNR values for medical images.

Keywords— SPIHT(Set Partitioning In Hierarchical Tree), Haar wavelet transform, Binary Thresholding, median filter, PSNR(Peak signal to noise ratio), ROI, NROI

INTRODUCTION

Image compression based on region of interest has been one of the hot issues in the field of image compression and coding. However, there is not a fixed model for region of interest automatic detected. In order to reduce storage spaces and transmission times of infrared target image data, a coding way is proposed for ROI automatic detected of image based on the region growing segmentation algorithm. In order to improve efficiency for transferring image data in real time, a coding-crossed algorithm for ROI automatic detected of infrared target image is studied as same time as it is realized on the frame of SPIHT Algorithm. An experimental study is also conducted that is proved the method of detecting automatically and compression algorithm based on region of interest automatic detected is reliable and effective, significant in applications. Non region of interest part is of lesser importance as it is the background part which is not much helpful in diagnosis of the disease. So, using the lossy method of compression for compressing the background part will make the compression more easier and will also not effect the issue of diagnosing the disease.

Currently, many applications want a representation of the image with minimal storage. Most images contain duplicate data. There are two duplicated parts of data in the image. The first is the existence of a pixel that has the same intensity as its neighboring pixels. These duplicated pixels waste more storage space. The second is that the image contains many repeated sections (regions). These identical sections do not need to be encoded many times to avoid redundancies and, therefore, we need an image compression to minimize the memory requirement in representing a digital image. The general principle used in the process of image compression is to reduce duplication of data within the image so that the memory needed to represent the image is smaller than the original image.

The block diagram of the proposed methodology is shown below in figure 1.

The methodology consist of following parts:-

1. Filtering
2. Segmentation of ROI and NROI
3. ROI compression using SPIHT Algorithm
4. NROI compression using Haar wavelet transform
**METHODOLOGY**

1. **FILTERING**

   In image processing, it is often desirable to be able to perform some kind of noise reduction on an image so that image could be clearly visible. In this methodology median filter is used.

   The median filter is a non linear digital filtering technique, often used to remove noise. Such noise reduction is a typical preprocessing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise.

   The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal. For 2D (or higher-dimensional) signals such as images, more complex window patterns are possible (such as "box" or "cross" patterns). In this methodology a brain tumor image is considered as shown below:

   ![Brain Image with Tumor](image)

   **Figure 2: Brain Image with Tumor**

**Figure 1: BLOCK DIAGRAM OF METHODOLOGY**
Noise in the form of salt & pepper noise is added. It is filtered with the help of median filter and output is shown below:

![Brain image with salt and pepper noise](image1.png)

![Filterd image](image2.png)

**Figure 3:** (a) Brain image with salt and pepper noise  (b) Filtered image (PSNR-37.8858 dB)

2. SEGMENTATION OF ROI AND NROI

In the proposed methodology Binary thresholding method is used for segmenting the image into ROI and NROI part.

Image thresholding is a simple, yet effective, way of partitioning an image into a foreground and background. This **image analysis** technique is a type of image segmentation that isolates objects by converting grayscale images into binary images. Image thresholding [6] is most effective in images with high levels of contrast. The simplest thresholding methods replace each pixel in an image with a black pixel if the image intensity is less than some fixed constant $T$ (that is), or a white pixel if the image intensity is greater than that constant.

In this method the ROI part is the tumor part in the brain having the intensity greater than the background part so tumor part is separated from the original brain image and further compressed for transmission.

The segmentation of ROI and NROI part is shown below:

![Outlined tumor part in the Brain image](image3.png)

![Binary image obtained after thresholding, threshold value($T=190$)](image4.png)

![Tumor part (ROI)](image5.png)

![Background part after removal of the tumor(NROI)](image6.png)

**Figure 4:** (a) Outlined tumor part in the Brain image  (b) Binary image obtained after thresholding, threshold value($T=190$)  (c) Tumor part (ROI)  (d) Background part after removal of the tumor(NROI)
3. SPIHT ALGORITHM

SPIHT (Set Partition in Hierarchical Trees) [5] is one of the most advanced schemes, even outperforming the state-of-the-art JPEG 2000 in some situations. The basic principle is the same; a progressive coding is applied, processing the image respectively to a lowering threshold. The difference is in the concept of zero trees (spatial orientation trees in SPIHT). There is a coefficient at the highest level of the transform in a particular sub band which considered insignificant against a particular threshold; it is very probable that its descendants in lower levels will be insignificant too. Therefore we can code quite a large group of coefficients with one symbol. A spatial orientation tree is defined in a pyramid constructed with recursive four sub bands splitting.

Normally most of an images energy is concentrated in the low frequency components Consequently the variance decreases as we move from the highest to the lowest levels of the sub band pyramid Furthermore it has been observed that there is a spatial self similarity between sub bands and the coefficients are expected to be better magnitude ordered if we move downward in the pyramid following the same spatial orientation [1].

![Flowchart of SPIHT](image)

**Figure 5**: Flowchart of SPIHT
In the proposed methodology the Brain tumor image is then separated into ROI and NROI part. The ROI part is compressed with help of SPIHT Algorithm and then reconstructed at receiver end. The PSNR of reconstructed image is calculated and shown below:

![Figure 7](image)

**Figure 7**: (a) ROI uncompressed part before applying SPIHT Algorithm (b) Reconstructed image of the tumor of the brain with PSNR=69.7988 dB for bpp=1.00

4. HAAR WAVELET TRANSFORM

Haar wavelet compression is an efficient way to perform both lossless and lossy image compression. It relies on averaging and differencing values in an image matrix to produce a matrix which is sparse or nearly sparse. A sparse matrix is a matrix in which a large portion of its entries are 0. A sparse matrix can be stored in an efficient manner, leading to smaller file sizes. In these notes we will concentrate on grayscale images; however, rgb images can be handled by compressing each of the color layers separately. The
basic method is to start with an image A, which can be regarded as an \( m \times n \) matrix with values 0 to 255. In Matlab, this would be a matrix with unsigned 8-bit integer values. We then subdivide this image into \( 8 \times 8 \) blocks, padding as necessary. It is these \( 8 \times 8 \) blocks that we work with.

In the proposed methodology the separated NROI part is compressed with the help of the Haar wavelet transform and then reconstructed at the receiver end. The PSNR of reconstructed image is calculated and shown below:-

![Image of brain MRI before and after compression](image1.png)

**Figure 8:** NROI uncompressed part before applying Haar Wavelet Transform (b) Reconstructed image of the background of the brain with PSNR=44.74 dB for bpp=1.00

**CONCLUSION**

At the final stage of the algorithm we have combined the background part and region of interest part and calculated the PSNR value. Table-1 illustrates compressed image quality with different bit rate values (number of bits per pixel). We have varied the bits per pixel from 0.25-2.00 Bpp and PSNR is calculated. We have compared our algorithm with SPIHT method of compression and we have found that our algorithm is better. From Table-1 it is evident that for higher bit rate higher PSNR is obtained and our algorithm shows better PSNR output than SPIHT. Hence we have obtained a satisfactory result and in future we would try to compress colored image.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>BPP (Bits per Pixel)</th>
<th>SPIHT (ROI) and HAAR (NROI)</th>
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**Table 1:** PSNR Calculation

**REFERENCES:**


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