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Medical Image Compression Using ISPIHT & JPEG2000 Hybrid

Yashpreet Sain

Final Year M. Tech, Department of Computer Science, Asra College of Engineering & Technology, Bhawanigarh (Sangrur)

Abstract: ***Image compression aims at reducing the size of an image without losing valuable information. It is needed in order to reduce the storage space and to minimize the transfer time over a network. Compression plays a more vital role in the field of medical imaging where a huge amount of storage is required to store these images and retrieve later for diagnosis. The Improved Set Partitioning in Hierarchical Trees is an enhanced SPIHT algorithm that is designed to provide maximum quality. However more optimum results can be obtained if it is combined with other techniques such as JPEG2000. In this paper I have tried to demonstrate how better image compression can be achieved by combining ISPIHT and JPEG2000 to create a new hybrid coder which gives better results as compared to the former methods. The results are compared on the basis of three quality matrices: PSNR, MSE and entropy.***

Keywords: Image compression, lossless compression, medical images, ISPIHT, JPEG2000, PSNR, MSE, Entropy

1. Introduction

The use of digital imaging in the field of medicine has increasing quickly therefore hospitals need to store a large quantity of data. Medical images are an important part of this. As a result hospitals have a great bulk of images with them and require a huge disk space and transmission bandwidth to store the images. In most cases transmission bandwidth is not enough to store all the image data. Image compression is the process of encoding information in fewer bits than a compressed representation that would use through use of specific encoding schemes. Compression is handy because it helps to decrease the need of valuable resources, such as hard disk space or transmission bandwidth decompressed. For example, a compression method for image may need a costly hardware for the image to be decompressed fast enough to be viewed as its being. The design of data compression schemes therefore involves balancing among various problems, including the amount of compression, the amount of distortion introduced (if using a lossy compression scheme), the computational resources required to compress and decompress the data. The use of computers and networks makes it easier to allocate the image data among the staff efficiently. The amount of data produced by medical imaging techniques is enormous and this might be a problem when sending the data over a network. To overcome this problem image compression has been introduced in the field of medicine.

2. Lossless Compression

Lossless or reversible compression is compression methods in which the revamped information precisely matches the first. Such compression systems give the assurance that no pixel contrast between the first and the compressed picture is over a certain limit. It finds prospective applications in remote sensing, medicinal and space imaging, and multispectral picture documenting. In these applications the volume of the information would call for lossy compression for useful stockpiling and transmission. Another approach to deal with the lossy-lossless dilemma confronted in applications, for example, therapeutic imaging and remote sensing is to utilize a progressively refinable compression strategy that gives a bit stream that prompts a dynamic remaking of an image. Utilizing wavelets, for instance, one can get an implanted bit stream from which different levels of rate and mutilation could be acquired. Numerous procedures have been found for conceivable use in tele-radiology where a specialist commonly asks for areas of a picture at enhanced quality while regions of an image at improved quality while accepting initial versions and insignificant parts at lower quality, and along these lines bringing down the general transfer speed prerequisites. Indeed, the new still picture layering standard, JPEG 2000, gives such peculiarities in its developed structure.

2.1 Joint Photographic Experts Group (JPEG)

JPEG stands for Joint Photographic Experts Group, the first name of the Committee that composed the standard. JPEG is intended for compacting full-shade or grey scale pictures of common, demonstrable scenes. It works well on photos, naturalistic craftsmanship, and comparable material; not all that well on lettering, basic comics, or line drawings. JPEG handles just still pictures, however there is a related standard called MPEG for movies.The JPEG2000 is a coding scheme that was presented in the year 2000; it provides both lossy and lossless compression schemes.

2.2 Set Partitioning in Hierarchical Trees (SPIHT)

SPIHT is the wavelet based image compression system. It gives the Maximum Image Quality, progressive picture transmission, completely installed coded record, Simple quantization calculation, quick coding/translating, totally versatile, Lossless compression, exact bit rate coding and Error protection [6]. SPIHT makes utilization of three rundowns – the List of Significant Pixels (LSP), List of Insignificant Pixels (LIP) and List of Insignificant Sets (LIS). These are coefficient area records that hold their directions. After the instatement, the calculation takes two stages for each one level of edge – the sorting pass (in which records are sorted out) and the refinement pass (which does the genuine dynamic coding transmission). The result is as a bit stream. It is equipped for improving the image consummately (each and every bit of it) by coding all bits of

the convert. Then again, the wavelet convert yields perfect recreation just on the off chance that its numbers are put away as boundless imprecision numbers. Top sign to-commotion proportion (PSNR) is one of the quantitative measures for picture quality assessment which is focused around the mean square slip (MSE) of the re-created picture. The MSE for N x M size picture is give:

$$MSE = \frac{1}{MN}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}\left\|I(i,j) - K(i,j)\right\|^2$$

Where *f (i,j)* is the original image data and *f ' (i,j)* is the compressed image value. The formula for PSNR is given by:

PSNR = 10 log $((255)^2$ / MSE)

2.3 Improved Set Partitioning in Hierarchical Trees (ISPIHT)

The improved SPIHT calculation basically rolls out the following changes. SPIHT codes four coefficients and after that shifts to the following four ones. Consequently, sees the four coefficients as a square. The most extreme of them viewed as the thought about limit will decrease number of inspections, which is related with the conveyance of coefficient grid. Thus, it can clearly diminish number of examination when checking and coding zero trees. The coefficients in non-important block will be coded in next scanning process or later, rather than be coded in the present scanning process. This method can implement the coefficients coded earlier to the non-important ones more adequately. Generally, wavelet transforms coding for still image using SPIHT [8]. Calculation could be demonstrated as Fig. Firstly, unique picture framework experiences wavelet convert. The yield wavelet coefficients are then quantized and encoded by SPIHT coder. After that, bit streams are obtained. Figure I. Wavelet transform image coding using SPIHT Traditional SPIHT has the advantages of embedded code stream structure, high compression rate, low complexity and easy to implement [9]. However, for it, there still exist several imperfections.

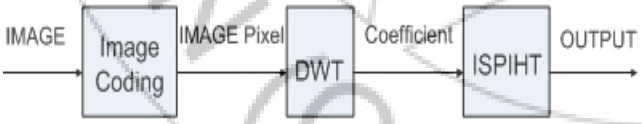


Figure 1: Block diagram of ISPIHT

3. Wavelet Transform

A Wavelet implies a "small wave". Wavelets are functions that used in representing data or other functions in mathematical terms. A wavelet is a waveform of a limited interval that has a normal estimation of zero. Wave in itself alludes to a function that is oscillatory. Furthermore Wavelet dissection can perform local analysis i.e. it can analyse a localized area of a larger signal i.e. it can investigate a limited zone of a bigger indicator.

4. Proposed Method

The proposed method is a combination of two lossless compression techniques; ISPIHT and JPEG2000. This method has been implemented on a set of various gray-scale medical images. The method proves to give better results than both ISPIHT and JPEG2000 compression methods. Both SPIHT and JPEG2000 provide good lossless compression and can be used for compressing images for web applications.

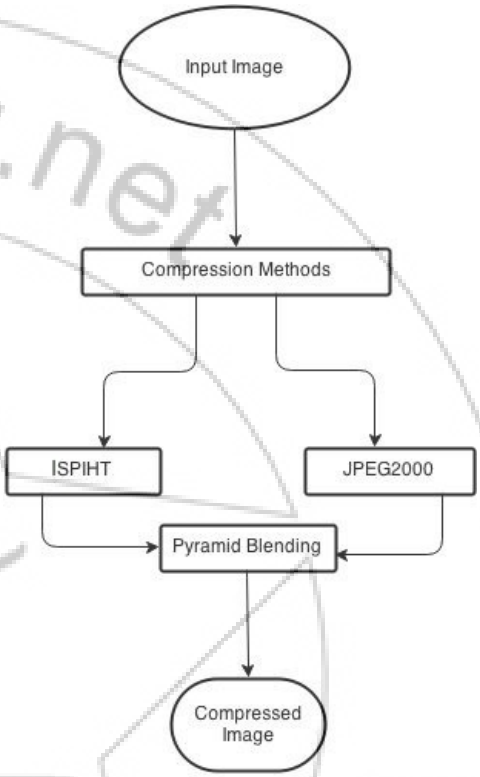


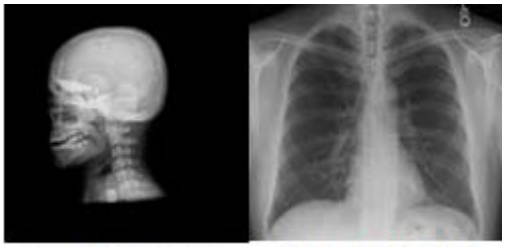
Figure 2: Flow Chart of the proposed method

5. Results and Discussion

Compression methods have been implemented using MATLAB (R2009a). Implementation of compression on images needs to focus on the fact that no valuable information is lost. Lossless compression aims to fulfill this need. However one lossless compression scheme does differ from the other and provide better results. Combining two different compression schemes can provide even better results. This has been shown by the results of the proposed method. This method has been implemented on a set of different gray-scale medical images. The different steps in the proposed algorithm are:

1) Consider the input image (gray-scale)
2) Compress the image using ISPIHT and JPEG200 differently and calculate PSNR, MSE and entropy
3) Combine the compressed images using pyramid blending and calculate PSNR, MSE and entropy of the final image.

The gray-scale medical images that used during the implementations are shown below:



Skull Radiograph Chest Radiograph

After compressing the above images, the resulting compressed images are shown in the figures below:

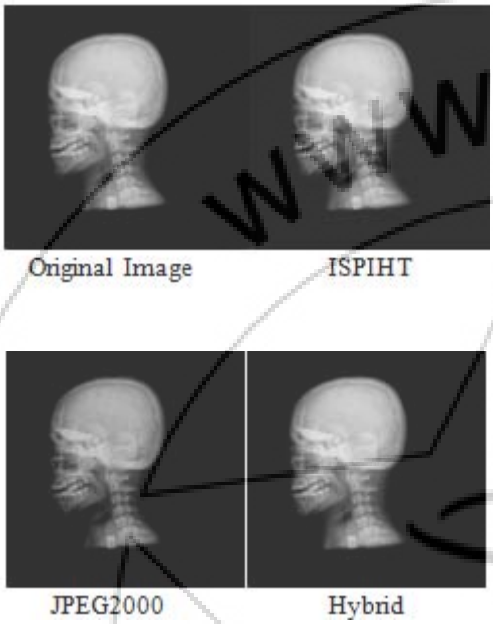


Figure 3: Skull Images

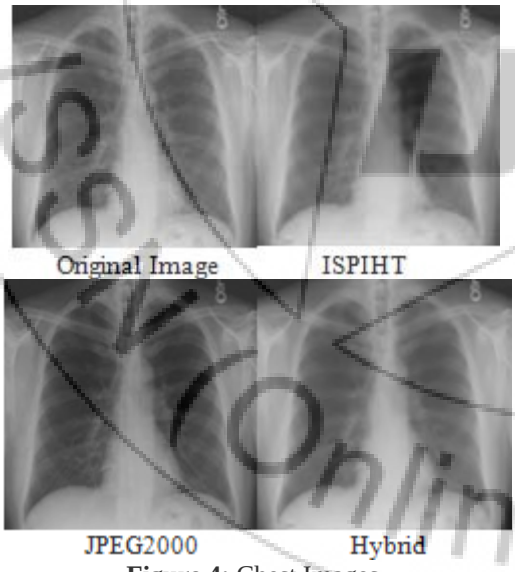


Figure 4: Chest Images

The values for PSNR, MSE and Entropy for the skull and chest image are as shown in the following table:

Image	*Compression Method*	*PSNR*	*MSE*	*Entropy*
Skull	ISPIHT	76.9012	9.37	3.42
Skull	JPEG2000	53.0642	145.638	2.7856
Skull	Hybrid	88.9576	2.3356	3.421
Chest	ISPIHT	73.802	13.3776	7.4256
Chest	JPEG2000	41.9976	520.7163	7.2826
Chest	Hybrid	76.7627	9.5136	7.4041

Figure 5: Values of different compression quality parameters

Graph showing variations for quality parameters for skull radiograph after applying different compression methods.

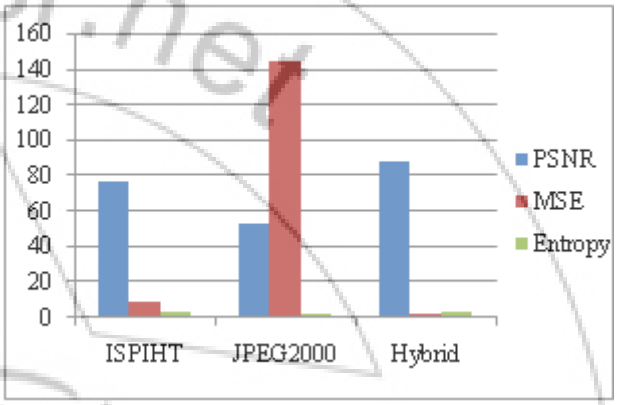


Figure 6: Comparison of Quality Parameters

Graph showing variations for quality parameters for chest radiograph after applying different compression methods.

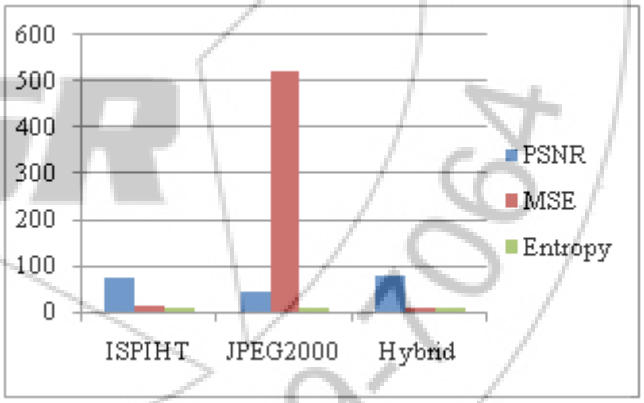


Figure 7: Comparison of Quality Parameters

It is clear from above findings that the value of PSNR comes to be highest in the proposed method. A high PSNR value means a high quality output image. Using the hybrid compression technique the values of PSNR for skull and chest radiograph come out to be 88.9576 and 76.7627 which are higher than the two compression methods. The value of mean squared error that specifies the amount of "error" in the resultant compressed image needs to be lower in value and the results show that the value of MSE is the lowest in case of the proposed method. The amount of information that must be coded by the compression algorithm is specified by the value of entropy. The results show that the loss of such information is minimized in the proposed method side by side giving a higher quality output image.

6. Conclusion

In this paper the performance of the hybrid compression method composed of ISPIHT and JPEG2000 is shown by the values of PSNR, MSE and entropy. Clearly the hybrid coding scheme provides better results than the former methods in terms of the quality parameters. High PSNR values show that the quality of the resulting image is of higher quality for the test images. The proposed method can be further used to combine other compression techniques with the SPIHT coding as SPIHT is considered to give high PSNR values as compared with other methods. Also the quality of medical images on the basis of quality parameters like compression ratio and bit per pixel can be analyzed.

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