MEDICAL IMAGE COMPRESSION BASED ON REGION OF INTEREST- A REVIEW

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ABSTRACT

In terms of transmission, bigger the size of any image, longer the time the channel takes for transmission. It is understood that the bandwidth of the channel is fixed. Therefore if the size of an image is reduced, more number of data or images can be transmitted over the channel .Compression is the technique used to reduce the size of an image. In terms of storage, compression reduces the file size which it occupies on the disk. Any image is based on two parameters, region of interest and non region of interest. There are several algorithms of compression that compress the data more economically. In this paper we have reviewed region of interest and non region of interest based compression techniques and there algorithms which compresses the image more efficiently.

KEYWORDS

Compression, Region of interest, DCT, DWT

1. INTRODUCTION

With the latest advancements in digital image processing, it is possible to perform image processing on digital images with the help of various algorithms for storage purpose. Storing the data in bulk may acquire a lot of space in the system. Therefore if the size of the image is reduced or compressed, then it might be possible to store any large number of images in a limited space. Image compression is the process of reducing an image so that irrelevant data is diminished without compromising the quality of an image and image can be transmitted efficiently through the communication channel.

The use of medical images compression came into existence when it was found that storing images in bulk may result in storage issue and thus only limited images can be stored.

Compression is not about making the size of image smaller or cropping an image. Compression deal with the quality of an image in such a way that no essential information is being lost. The compression may be further defined in terms of two parameters, that is, lossless and lossy compression, and there are several algorithms that are applied for image compression based on lossless and lossy compression as discussed below.

1.1 Lossless Compression

Lossless compression is a compression technique in which the compression takes place such that no important information is lost. In this type of compression redundant data is removed. In other words, if any image is losslessly compressed, then it can be recovered back to the original image by applying compress cycle.

There are two algorithms which are commonly used for lossless compression.

1. Run length coding
2. Huffman coding
3. Wavelet Transform

1.2 Lossy Compression

As the name implies, lossy compression means there is some loss in information. In this technique, the redundant information is completely removed. Only required part of the data is compressed and rest all the redundant data is removed. The following are the algorithms that are applied on lossy compression.

1. Discrete cosine transform
2. Fractal compression
3. Fractional Talbot effect

Out of these many algorithms for lossless and lossy compression, two algorithms, namely discrete wavelet transform (DWT) and Discrete Cosine transform (DCT) are used for lossy and lossy compressions respectively.
Specifically these two algorithms are used for compression as DCT gives improved results when used for lossy compression and DWT gives superior results when used for lossless compression.

2. MEDICAL IMAGING

Medical imaging is the technology used to outlook the human body so that it can easily diagnose the disease if present. Under medical imaging there are several other technologies that are used to diagnose different parts of the human body. These are namely, ultrasound imaging, magnetic resonance imaging (MRI), medical X-ray, endoscopy, radiology etc. Every type of these technologies gives distinct information about the disease.
Compression of medical images is done on the basis of two parameters.

1. Region of interest (ROI)
2. Non region of interest

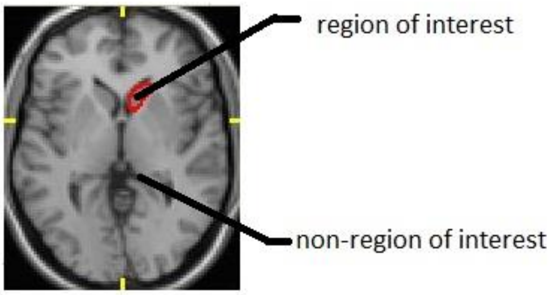

Figure 1. Region of interest and non region of interest area

2.1 Region of interest

Region of interest is that area of an image which is treated as the most important part and needs to be diagnosed. It is extracted from the original image. The method where the ROI and non ROI are separated is known as segmentation. Region of interest is compressed using lossless compression as it the area which is to be diagnosed therefore it is compressed so that image quality does not get reduced. Thus region of interest is compressed using discrete wavelet transform.

2.2 Non region of interest

Non region of interest is that area of an image which is not so considerable. It is compressed using lossy compression. The redundant data is removed permanently. And it can be recovered back to the original image. Discrete cosine transform is used to compress non region of interest.

Mathematically the level of compression can be analyzed by calculating compression ratio. For any compressed image, compression ratio must be as high as possible. The compression ratio is given as:-

$$CR = \frac{\text{size of compressed image}}{\text{Size of original image}}$$

As an example, if the compression ratio for an image is calculated as 10:1, that means that the original image is ten times larger in size to that of compressed image. After the image is compressed the size of an image gets reduced and hence increases the transmission time over the channel.

3. LITERATURE SURVEY

In 2015, Renjun Shuai, Yang Shen, Jing Pan proposed an algorithm for medical image compression [1] in which they first worked on image segmentation, the region of interest is extracted and compressed with shearlet. On the other hand non region of interest is compression using wavelet and fractal method which results greatly improves the compression ratio.

In 2014, S.Sangeetha, M.Manimozhi, E.Priyanga, S.Hema proposed SPIHT (Set Partitioning in Hierarchical Trees) algorithm [2] for segmenting the region of interest, results in higher compression ratio keeping the quality of an image.

Mrs.S.Sridevi, Dr.V.R.Vijayakuymar, Ms.R.Anuja [3] surveyed various compression methods for medical images. The paper compares various compression methods such as discrete cosine transform, discrete wavelet transform, scaling based ROI, and Sub band Block Hierarchical Partitioning on the basis of compression ratio.

Razavi Hesabi, Z. Sardari, M. Beirami, A. Fekri, F. Deriche, M. Navarro in 2014 [4] presented a memory assisted lossless compression algorithm for medical images worked to further eliminated redundancies in an image. Here Principal Component Analysis (PCA) is applied on images to form the required reference models.

S. Bhavani, K.G. Thanushkodi [5] in 2013 proposed an algorithm which allows reduction of encoding time and improvement in the compression ratio.

P. E. Sophia, J. Anitha [6] in 2014 presented the paper on Implementation of region based medical image compression for telemedicine application which increases the compression ratio compared to other methods. They analyzed the distortion rate and compression rate.

Mr. Amit S. Tajne, Prof. Pravin S. Kulkarni [7] surveyed on medical image compression using hybrid technique where they described various compression techniques and also explained algorithms such as discrete cosine transform, wavelet transform and Huffman compression.

4. DISCRETE COSINE TRANSFORM

The pixel in an image is most important so we cannot eliminate any of the pixels. One of the core applications how JPEG works is to apply DCT to every block of 8*8 pixels. DCT converts the sequence of data into frequency domain. Although discrete Fourier transform is more popular, it cannot be used in place of DCT due to its complexity.

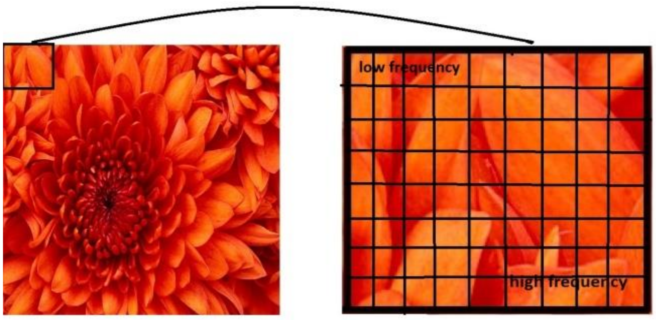

Figure 2. Discrete cosine transform

High frequency components are less sensitive to our eyes; it can be treated as redundant data. Some data appear more important than others because human eye is not so good at noticing high frequency. Smoother the image is the more low frequency component it has. Hence DCT separates the low and high frequency coefficients.

DCT works by separating images into the segments of different frequencies. During quantization step, where parts of compression actually occur, the frequencies which is less important (higher frequencies) are discarded, hence the use of lossy. The most important frequencies (low frequencies) that remain are used to retrieve the image in the decomposition process; as a result, the regenerated image is distorted.

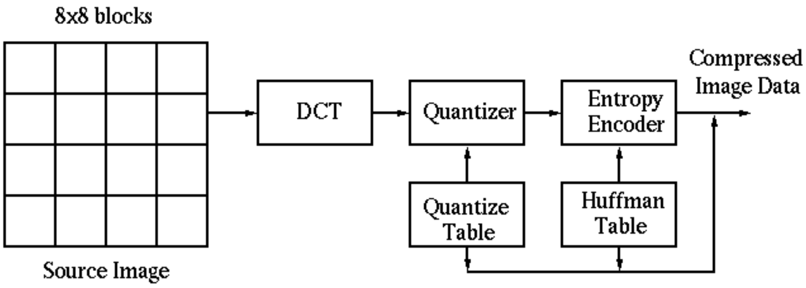

Figure 3. Encoder

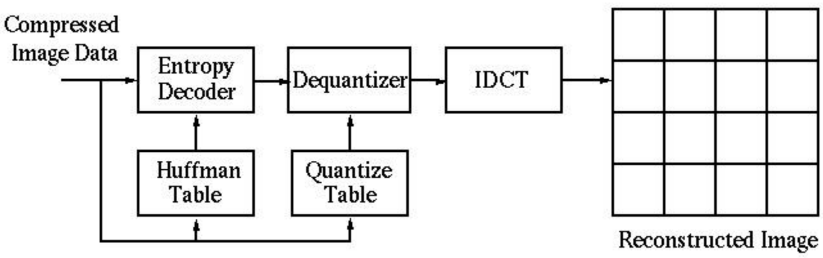

Figure 4. Decoder

We can apply discrete wavelet transform in lossy but cannot apply DCT in lossless due to the following reasons:-

1. In DCT we classify low and high frequency components and neglect the high frequency component as it is not visible to human eyes.
2. In the process of reconstruction of DCT, we get distorted image.

5. DISCRETE WAVELET TRANSFORM

Wavelet can be defined as a mathematical function which divide the data into various frequency components and scale each of the components according to its scale. In other words wavelet can be treated as small waves. While comparing with Fourier transform, Fourier transform represents a signal in terms of sinusoids and does not give any information in time domain. On the other hand, wavelet transform is localized in both time and frequency domain and are obtained using scaling method.

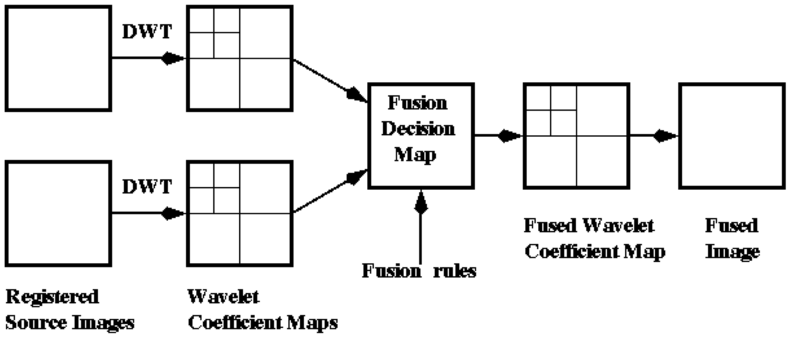

Figure 5. Discrete wavelet transform

Need:-wavelet transform analyze discontinuities and sharp spikes of the signal.

Application:- image compression, human vision, radar, earthquake prediction.
Wavelet transform is based on Heisenberg's uncertainty principle. Therefore wavelets are designed in such a way that we get high frequency resolution for low frequency components and temporal resolution for high frequency components.

6. APPLICATIONS

There are various applications of digital imaging in medical fields.

1. MRI images of human body parts
2. Imaging in the radio band
3. Space borne radar
4. Imaging in the microwave band
5. Images from the satellite
6. Imaging in the visible and infrared band
7. Astronomical images
8. Imaging in the ultraviolet band
9. Gama ray imaging
10. X-ray imaging

7. CONCLUSION

The paper has a brief review on compression techniques, lossless and lossy compression and their algorithms. The paper also discussed medical image compression and its techniques. It can be concluded that for storage purpose medical images can be compressed efficiently by applying algorithms on the region of interest, from which the infected area can be treated, and the non region of interest. Future work can be presented by applying algorithm which can bring out improved value of the compression ratio, so that the compressed image possess a good quality, and can be able to acquire minimum storage capacity.

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