IMAGE COMPRESSION TECHNIQUES FOR MEDICAL IMAGES: A REVIEW

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ABSTRACT

We can see the rapidly increasing use of images in various applications like in automation, security systems, in robotics and in medical treatments. The medical images like Ultrasound, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) contains large volume of data. These medical images produce the human body pictures in digital form and due to rapid growth in technology various mobile equipments has been developed for the medical treatments which uses digital medical images so it is very important to reduce the size of medical images. The efficiency should be very high in medical images because it can cause loss of a life so medical image compression requires negligible information loss. In this paper we have presented various effective algorithms used for compression.

Keywords: *CT, MRI, LZW, PSNR, Entropy, Huffman Coding, Arithmetic Coding, RLE Coding & Wavelet Compression.*

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I. INTRODUCTION

Despite the technological advances in storage and transmission, the demands placed on the storage capacities and on the bandwidth of communication exceed the availability. Due to rapid increase in medical data produced by hospitals, compression of images is becoming increasingly important. Because of the high cost of providing a large transmission bandwidth and huge amount of storage space, many novel and efficient image compression approaches are introduced. Storing digital medical images is standardized by DICOM (Digital Imaging and Communications in Medicine) [3]. Compression schemes are divided into two categories Lossless or reversible and lossy or irreversible compression [6]. Compression methods used for medical images are most of the time lossless methods in order to preserve the original data information which helps for true diagnosis. Lossless compression also called entropy coding [1].

This paper revised the different image compression techniques and comparative analysis between DWT based image compression and DCT based image compression for medical images and tells DWT is best for medical image compression with high efficiency of compression with minimum information loss.

II. LOSSLESS IMAGE COMPRESSION

In lossless compression original image can be recovered perfectly from the compressed (encoded) image also called entropy coding since they use statistical/decomposition techniques to remove/reduce the redundancies from the image [1]. Various methods like, Run-length coding, Huffman, Arithmetic coding have been used for obtaining error free compression.

Run length encoding*:* In this coding scheme sequence of same symbols called runs replaced by shorter symbols. This step used as post processing step after applying the lossy compression scheme to the image getting a set of data values [1].

Huffman coding*:* Huffman coding was developed by David Huffman for removing coding redundancy. It creates variable length codes that are an integral number of bits [6]. This is a general technique for coding symbols based on their statistical occurrence frequencies (probabilities). The pixels in the image are treated as symbols. The symbols that occur more frequently are assigned a smaller number of bits, while the symbols that occur less frequently are assigned a relatively larger number of bits. Huffman code is a prefix code. This means that the (binary) code of any symbol is not the prefix of the code of any other symbol. Most

image coding standards use lossy techniques in the earlier stages of compression and use Huffman coding as the final step [1].

Arithmetic coding: This coding is also statistical coding like Huffman coding but Huffman coding treated every symbol separately and assigned codes but Arithmetic coding replaced whole data sequence with a single code.

Lempel-Ziv-Welch Coding: This is based on storing frequently occurring sequences of symbols (pixels) in a dictionary (table). Such frequently occurring sequences in the original data (image) are represented by just their indices into the dictionary. This has been used in TIFF (Tagged Image File Format) and GIF (Graphical Interchange Format) file formats. This scheme has also been used for compressing half-tone images. (Half-tone images are binary images that provide the visual effect of continuous-tone gray images by using variations of the density of black dots in the images) [1].

III. LOSSY IMAGE COMPRESSION

In lossy compression scheme the original image cannot be recovered perfectly from the compressed image. Some data will be lost after compression but lossy compression provides high compression ratio to increase the storage capacity and decreases the bandwidth requirements. Many lossy encoding techniques are capable of reproducing recognizable monochrome images from data that have been compressed by more than 100:1. The principle difference between lossy and lossless encoding techniques is the presence or absence of the quantization [6].

Transform Coding: These compression techniques are based on modifying the transform of an image. In transform coding, a reversible, linear transform such as DFT discrete cosine transform and DCT discrete cosine transform are used to change the pixels in the original image into a set of transform coefficients (frequency domain coefficients), which are then quantized and coded [1].

JPEG coding: Joint picture expert group is a standard used for compressing the color images and gray scale images. JPEG consists of four modes- Lossless, sequential, progressive and hierarchical. First one is lossless and other three are lossy compression [1].

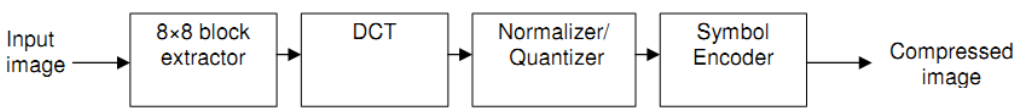

Fig.1. JPEG compression scheme [6].

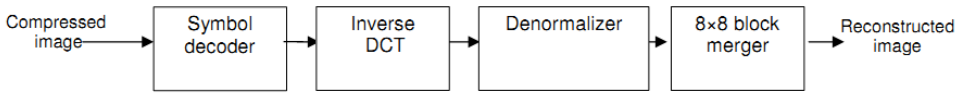

Fig.2. JPEG Decompression scheme [6].

The most commonly used is sequential also called baseline which provides high efficiency of data compression. In JPEG compression first the image is divided into nxn square matrix which is non overlapping blocks. To reduce the complexity the most commonly used block is 8 x 8 pixels after that DCT is applied to each block to get the transform coefficients. The resulting coefficients than quantized using standard table of quantization step sizes and the quantized coefficients are rearranged in zigzag scan for further compression by using RLE, Arithmetic or Huffman coding schemes. We are using quantization in JPEG process some information will lost so called lossy compression scheme.

Wavelet compression: The basic idea of the wavelet transform is to represent any arbitrary function (t) as a superposition of a set of such wavelets or basis functions. These basis functions or baby wavelets are obtained from a single prototype wavelet called the mother wavelet, by dilations or contractions (scaling) and translations (shifts). The Discrete Wavelet Transform of a finite length signal x(n) having N components, for example, is expressed by an N x N matrix [7].

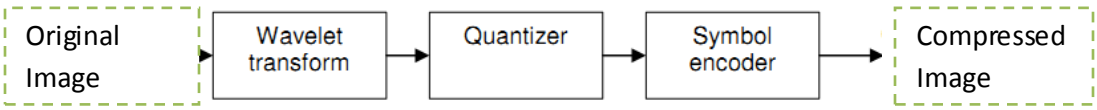

Fig.3.Wavelet compression coding system [6].

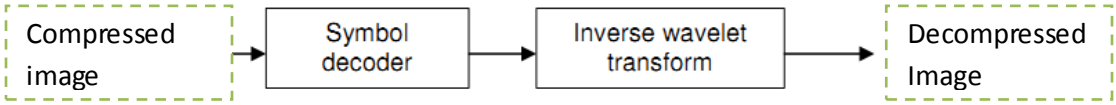

Fig.4. Wavelet decompression system [6].

Wavelet compression scheme is having many advantages over JPEG compression we get blocking artifacts in JPEG but wavelet compression reduced the blocking effect by using smoothly overlapping blocks. JPEG 2000 is a new lossy to lossless compression technique which uses DWT instead of DCT.

Wavelet scheme is more robust under transmission and decoding errors and facilitates progressive transmission of images [7] because of their inherent multi resolution nature wavelets schemes are suitable for applications where scalability and tolerable degradation are important.

CONCLUSION

By studying and discussing all the techniques we find lossy compression techniques provides high compression ratio than lossless compression scheme. Lossless compression schemes are more suitable for text compression in which they provides high compression ratio without any data loss but in image compression ratio we use lossy compression scheme for getting high compression ratio. By using lossy compression schemes we also lose some data and in medical image processing there should be minimum loss of data which do not affects the end results. Wavelet compression provides high data compression ratio and minimized the MSE and maximize the PSNR. So wavelet compression is better for medical image compression.

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