Overview Of Compression Techniques And Their Comparison On Medical Images

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ABSTRACT – Image compression is a technique by which we can reduce the storage space of images which help in increasing the storage and increases the performance. In this paper, overview of image compression techniques is given. Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) and their comparison is presented on the basis of compression parameters. Hybrid Transform technique is also discussed in the paper which is also a compression technique that uses combined DCT and DWT approach.

Keywords - DCT, DWT, Image Compression.

I.INTRODUCTION

Image compression is very important for efficient transmission and storage of images. Demand for communication of multimedia data through the telecommunications network and accessing the multimedia data through Internet is growing explosively. With the use of digital cameras, requirements for storage, manipulation, and transfer of digital images, has grown explosively. These image files can be very large and can occupy a lot of memory. The basic objective of image compression is to find an image representation in which pixels are less correlated. The two fundamental principles used in image compression are redundancy and irrelevancy. Redundancy removes redundancy from the signal source and irrelevancy omits pixel values which are not noticeable by human eye. JPEG and JPEG 2000 are two important techniques used for image compression. Image compression standards bring about many benefits, such as: (1) easier exchange of image files between different devices and applications; (2) reuse of existing hardware and software for a wider array of products; (3) existence of benchmarks and reference data sets for new and alternative developments.

The problem faced by image compression is very easy to define, as demonstrated in figure 1. First the original digital image is usually transformed into another domain, where it is highly de-correlated by using some transform. This decor relation concentrates the important image information into a more compact form. The compressor then removes the redundancy in the transformed image and stores it into a compressed file or data stream. In the second stage, the quantization block reduces the accuracy of the transformed output in accordance with some pre-established fidelity criterion. Also this stage reduces the psycho-visual redundancy of the input image. Quantization operation is a reversible process and thus may be omitted when there is a need of error free or lossless compression. In the final stage of the data compression model the symbol coder creates a fixed or variable-length code to represent the quantize output and maps the output in accordance with the code. Generally a variable-length code is used to represent the mapped and quantized data set. It assigns the shortest code words to the most frequently occurring output values and thus reduces coding redundancy. The operation in fact is a reversible one. The decompression reverses the compression process to produce the recovered image as shown in figure 2. The recovered image may have lost some information due to the compression, and may have an error or distortion compared to the original image.

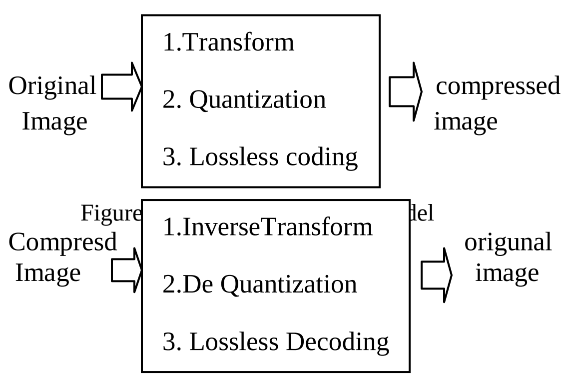

Figure 2: Image Decompression Model

II. IMAGE COMPRESSION TECHNIQUES

The objective of image compression is to reduce irrelevance and redundancy of the image data in order to be able to store or transmit data in an efficient form. The best image quality at a given bit rate is the main goal of image compression. The quality of a compression method often is measured by the peak signal to noise ratio. It measures the amount of noise introduced through a lossy compression of the image. Image compression can be of following types:

Lossless Compression: In lossless compression schemes, the reconstructed image, after compression, is numerically identical to the original image. However lossless compression can only achieve a modest amount of compression. Lossless compression is preferred for archival purposes and often medical imaging, technical drawings, clip art or comics**.**

Lossy compression: Lossy schemes are capable of achieving much higher compression. Lossy methods are especially suitable for natural images such as photos in applications where minor (sometimes imperceptible) loss of fidelity is acceptable to achieve a substantial reduction in bit rate. The lossy compression that produces imperceptible differences can be called visually lossless.

Predictive Coding: In predictive coding, information already sent or available is used to predict future values, and the difference is coded. Since this is done in the image or spatial domain, it is relatively simple to implement and is readily adapted to local image characteristics. Differential Pulse Code Modulation (DPCM) is one particular example of predictive coding.

Transform coding: Transform coding, on the other hand, first transforms the image from its spatial domain representation to a different type of representation using some well-known transform and then codes the transformed values (coefficients). This method provides greater data compression compared to predictive methods, although at the expense of greater computational requirements

III. IMAGE COMPRESSION USING DISCRETE COSINE TRANSFORM (DCT)

JPEG is primarily a lossy method of compression. JPEG was designed specifically to discard information that the human eye cannot easily see. Slight changes in color are not perceived well by the human eye, while slight changes in intensity (light and dark) are. Therefore JPEG's lossy encoding tends to be more frugal with the gray-scale part of an image and to be more frivolous with the color.DCT separates images into parts of different frequencies where less important frequencies are discarded through quantization and important frequencies are used to retrieve the image during decompression. Compared to other input dependent transforms, DCT has many advantages: (1) It has been implemented in single integrated circuit; (2) It has the ability to pack most information in fewest coefficients; (3) It minimizes the block like appearance called blocking artifact that results when boundaries between sub-images become visible.

The forward 2D_DCT transformation is given by the following equation:

$$C(u,v)=D(u)D(v)\sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)\cos[(2x+1)u\pi/2N]\cos[(2y+1)v\pi/2N]$$

Where u, v=0, 1, 2, 3 ,……………., N-1

(1)

The inverse 2D-DCT transformation is given by the following equation:

$$f(x,y)= \sum_{u=0}^{N-1}\sum_{v=0}^{N-1} D(u)D(v)D(u,v)\cos[(2x+1)u\pi/2N]\cos(2y+1)v\pi/2N]$$

Where $D(u) = (1/N)^{1/2}$ for u=0

$D(u) = 2(/N)^{1/2}$ for u=1, 2, 3……., (N-1)

(2)

IV. IMAGE COMPRESSION USING DISCRETE WAVELET TRANSFORM (DWT)

Wavelet Transform has become an important method for image compression. Wavelet based coding provides substantial improvement in picture quality at high compression ratios mainly due to better energy compaction property of wavelet transforms. Wavelet transform partitions a signal into a set of functions called wavelets. Wavelets are obtained from a single prototype wavelet called mother wavelet by dilations and shifting. The wavelet transform is computed separately for different segments of the time-domain signal at different frequencies.

A. Subband coding

A signal is passed through a series of filters to calculate DWT. Procedure starts by passing this signal sequence through a half band digital low pass filter with impulse response h(n).Filtering of a signal is numerically equal to convolution of the tile signal with impulse response of the filter.

$$x[n]*h[n] = \sum k = -\infty \text{ to } \infty \ x[k].h[n-k] \ k$$

A half band low pass filter removes all frequencies that are above half of the highest frequency in the tile signal. Then the signal is passed through high pass filter. The two filters are related to each other as

$$h[L-1-n] = (-1)^n g(n)$$

Filters satisfying this condition are known as quadrature mirror filters .After filtering half of the samples can be eliminated since the signal now has the highest frequency as half of the original frequency. The signal can therefore be sub sampled by 2, simply by discarding every other sample. This constitutes 1 level of decomposition and can mathematically be expressed as

$$Y1[n] = \sum k = -\infty \text{ to } \infty \ x[k]h[2n-k] \ k$$

$$Y2[n] = \sum k = -\infty \text{ to } \infty \ x[k]g[2n+1-k] \ k$$

Where y1[n] and y2[n] are the outputs of low pass and high pass filters, respectively after sub sampling by 2.

This decomposition halves the time resolution since only half the number of sample now characterizes the whole signal. Frequency resolution has doubled because each output has half the frequency band of the input. This process is called as sub band coding. It can be repeated further to increase the frequency resolution as shown by the filter bank.

*B. Compression steps***:**

1. Digitize the source image into a signal s, which is a string of numbers.
2. Decompose the signal into a sequence of wavelet coefficients w.
3. Use threshold to modify the wavelet coefficients from w to w'.
4. Use quantization to convert w' to a sequence q.
5. Entropy encoding is applied to convert q into a sequence e.

V. IMAGE COMPRESSION USING HYBRID TRANSFORM

In this approach, also known as combined approach, both DCT and DWT are carried out on the image in some sequence one after the other in order to compress the image much more and achieve higher compression ratios. Compression increases with increase in window size for DCT and decreases with increase in window size for DWT. Here in this approach, first the image is divided into several blocks of images of some size. Then we will apply DWT and DCT equations for compression on various blocks and then merging is performed in order to retrieve the compressed image. The compressed image occupies less space as compared to original image as well as less than the space occupied by the image when compressed via DCT and DWT individually.

VI. CONCLUSIONS

In this paper, we have presented the techniques that compress the medical images with the help of Discrete Cosine Transform (DCT), Discrete wavelet Transform (DWT) and the Hybrid approach. In this the attention is being paid to all the techniques that compresses the medical images to their best extent and will produce the accurate results that will help the doctors to do their various researches, therefore to increase the accuracy. In future, the comparative study of both the techniques will be done with the help of various performance measures which will be based on the compression parameters.

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