Medical Images Compression Techniques

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Abstract – medical images are having a very significant role in health sciences. Medical images are produced by the mechanism of medical imaging which is the process of creating images of the human body or body parts using various techniques to reveal, diagnose or treat a disease. Analysis of these images by the experts lead to detection of a certain and specific medical condition. Storage and sharing of medical image data are expensive and excessive without compressing it because various techniques of medical imaging produce large sized data therefore these medical images are compressed before saving or sharing them. We present a new hybrid discrete cosine transform and Huffman encoding to bring about compression and noise removal in further steps and then image similarity detection by Fourier transform

Keywords – Compression, Discrete Cosine Transform, Huffman encoding, Fourier transform, Correlation

1. Introduction

Medical image Compression techniques reduce the irrelevance and redundancy of the image data in order to be able to store or transmit data in an efficient form. Image compression is a process of decreasing size in bytes without compromising with the image quality upto below par level. Compressed images have advantage over uncompressed images in low memory requirement for storage. And also reduction of to be sent over the Internet or downloaded from Web pages. It is the useful process to save a lot of space and resources while sending images from one place to another. It eliminates the redundant part and functions which can be generated at the time of decompress. Hence, Compression of medical images plays an important role for efficient storage and transmission [1].The main goal is to achieve higher compression ratios and minimum degradation in quality [2]. The medical image compression techniques uses different medical images like X-Ray angiograms, Magnetic resonance images (MRI), Ultrasound and Computed Tomography (CT). DICOM (Digital imaging and communications in medicine) is used for storing, transmitting and viewing of the medical images

1.1. Medical Image Compression System

The basic system for the purpose of compression is represented and its various methods are given. Later on, the hybrid technique of discrete cosine transform is discussed. The discrete cosine transform belongs to the family of sinusoidal unitary transforms. They are real, orthogonal and separable with fast algorithms for its computation.

1.2 Image Compression Model

The compression system removes the redundancies from the images through a sequence of three independent operations. In the initial stage, an image is fed into the mapper, which reduces spatial and temporal redundancy from the image. The function of a Quantizer is to keep the irrelevant information out of the compressed form. In the final stage, the symbol coder generates a fixed- length or variable- length code to represent the quantizer output and maps the output according to the code [3].The model of image compression system is shown below in Figure1.

Figure 1 Image Compression model

1.3 *Image Compression techniques*

The image compression techniques can be broadly classified into two categories as Looseless and Loosy Compression. In Looseless Compression, the original image can be reconstructed from the compressed image. This technique is widely used in medical imaging since they do not add noise to an image [4]..In Loosy compression technique, the reconstructed image contains some degradation as compared to the original one but it is nearly close to it. Lossy compression produce some compession by-products when used at low bit rates.lossy compression methods, especially when used at low bit rates, introduce compression artifacts This technique provides much higher compression ratios than the looseless scheme [5]. Following are some Looseless and Looosy data compression techniques:

1. Looseless techniques
   - i) Run-Length encoding
   - ii) Huffman encoding
   - iii) Arithmetic coding
   - iv) LZW coding
   - v) Area coding
2. Loosy Techniques
   - i) Transform coding (DCT/DFT)
   - ii) Predictive coding
   - iii) Wavelet coding

1.4 *Discrete Cosine Transform*

The transform coding comprises an important component of image processing applications. A transform coding involves subdividing an N×N image into smaller non-overlapping n×n sub-images blocks and performing a unitary transform on each block. Transform coding relies on the fact that pixels in an image exhibit a certain level of correlation with their neighboring pixels. These correlations can be exploited to predict the value of a pixel from its respective neighbors [6]. Therefore, transformation maps the spatial (correlated) data into transformed (uncorrelated) coefficients. Dct donot use sine functions, nstead of this it uses cosine function.this property of dct is having significant impact because icosine functions are known to be much more. DCT has some advantages over DFT as DCT is having better computational efficiency as it's a real transform system and moreover DCT doesnot produce discontinuity in the time signal in the process of peroidicity

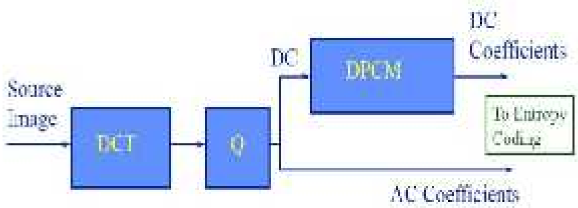
The most common discrete cosine transform definition of a one dimensional sequence of length N is given by the equation

$$X[n] = \alpha[n] \sum_{m=0}^{N-1} x[m] \cos\left(\frac{(2m+1)n\pi}{2N}\right) = \sum_{m=0}^{N-1} x[m] c[n,$$

Where α[n] = For n=0 and

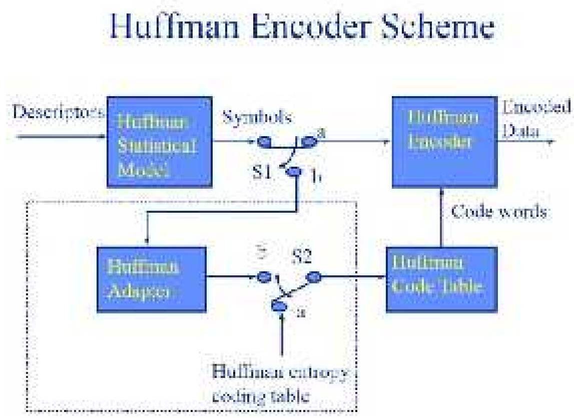
For n=1, 2…N-1

DCT is a type of Fourier related transform but it operates only on real numbers. The main difference between DCT and DFT is that the former uses only cosine functions while the latter uses both cosines and sines. Also, DCT has better computational efficiency and it imposes periodicity in the time signal without introducing any discontinuity



1.5 Huffman Encoding

The Huffman coding is a looseless data compression technique for removing the coding redundancy. It uses a small number of bits to encode common characters. Huffman coding approximates the probability for each character as a power of 1/2 to avoid complications associated with using a nonintegral number of bits to encode characters using their actual probabilities.The Huffman encoding is uniquely decodable and instantaneous because the code symbols in a string can be decoded in one way only and without referencing any succeeding symbols. It creates optimal code for a set of symbols and probabilities subject to the constraint that the symbols can be coded one at a time [1]. The Huffman code procedure is based on the fact that the symbols which occur more frequently have shorter code words than symbols which occur less frequently. Also, the two symbols which occur least frequently will have the same length. [7]



The first step in Huffman coding algorithm is to produce a sequence of source reductions by combining the lowest probability symbols into a single symbol and this process is repeated until a reduced source with two compound symbols is left. This is shown by an example in table 1.

At the far left of the table 1 a series of source symbols is listed and their corresponding probability is arranged in their decreasing order. The first source reduction is formed by merging the lowest two probabilities, 0.06 and 0.04 and this yields the probability of 0.1, which is placed in the first column of the source reductions. The probabilities are placed such that they are always in their decreasing order. This process is repeated until the two probabilities, 0.6 and 0.4 are left at the end as shown in the last column of source reduction. The second step in this method is to generate a code tree starting with the smallest source and going back towards the original source. This is illustrated by in table 2. The minimum length of binary code for a two -symbol source is the symbols 0 and 1.The reduced source symbol with probability 0.6 was generated by merging the two symbols in the reduced source to its left, the 0 which was used to code it is now assigned to both its symbols and these symbols are further appended by adding a and 1 to each of them so that they can be distinguished from each other. This procedure is repeated until the final code is produced at the far left of the table 2 [8].

Table 1 : Huffman source reductions

Original Source		Source Reductions			
Symbol	Probability	1	2	3	4
a_2	0.4	0.4	0.4	0.4	0.6
a_6	0.3	0.3	0.3	0.3	0.4
a_1	0.1	0.1	0.2	0.3	
a_4	0.1	0.1	0.1		
a_3	0.06	0.1			
a_5	0.04				

Table 2. Huffman code assignment procedure

Original Source			Source Reductions			
S	P	Code	1	2	3	4
a_2	0.4	1	0.4 1	0.4 1	0.4 1	0.6 0
a_6	0.3	00	0.3 00	0.3 00	0.3 00	0.4 1
a_1	0.1	011	0.1 011	0.2 010	0.3 01	
a_4	0.1	0100	0.1 0100	0.1 011		
a_3	0.06	01010	0.1 0101			
a_5	0.04	01011				

The average length of the code is given by:

L_{avg} = (0.4)(1) + (0.3)(2) + (0.1)(3) + (0.1)(4) + (0.06)(5) + (0.04)(5)

= 2.2 bits/symbol

Entropy of the source is 2.14 bits/symbol.

The resulting Huffman code efficiency is 2.14/2.2=0.973.

Entropy, H= (a_1) (a_j)

2. Proposed algorithm

The compression algorithm for medical images is based on the discrete cosine transform and it comprises of the following steps:

1. Retrievel of images from medical databases.
2. Conversion of the colored image into grayscale image.
3. Preprocessing of medical images by discrete cosine transform based compression to eliminate undesired signals, symbols that arise with acquisition process.
4. Further, Huffman encoding will be performed for eliminating any unwanted noise and pending redundancy of sequence and symbols.
5. Images will be processed through Fourier transform to find the amplitude difference with correlation method and will identify the similarity between two images.
6. Finally, the comparison of the images will be done to find the best similarity result with compression.

3. Conclusion

The paper shows that using Fourier transform and Discrete Wavelet transform, the software is developed under Matlab mathematical platform that allows the efficient compression of the medical images. Our main focus is to bring about compression in images without compromising the quality by our. Our technique will proved to be recent advancement in medical image compression.

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