ISSN: 2277-9655
Impact Factor: 1.852

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

A Hybrid Discrete Cosine Transform Technique for Compression of Medical Images

Arshleen
Scholar, Department of Computer Science and Engineering, Chandigarh Engineering College, Landran, Mohali, Punjab, India
arshleen_27@yahoo.co.in

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 correlation is done.

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

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

Medical images

The biomedical imaging's scope covers image reconstruction, data acquisition, and image analysis, methods, systems, involving theories, and applications. While post-processing and tomographic techniques become increasingly advanced, traditional and emerging techniques play more and more crucial roles in anatomical, molecular, cellular and functional imaging. Medical imaging is the technique and process used to create images of the human body and structures for clinical purposes (medical processes looking to unveil, diagnose, or examine disease) or medical science (invloving the study of basic anatomy and physiology). Although for medical reasons imaging of removed organs and tissues can be performed, but such procedures are usually referred to as part of pathology rather than medical imaging. In its widest sense and as a discipline, it is part of biological imaging and incorporates radiology (in the wider sense), nuclear medicine, investigative endoscopy , radiological sciences, , medical photography ,(medical) thermography, and microscopy (e.g. for human pathological investigations). Primarily designed Measurement and recording techniques which are not supposed to produce images, such, magneto encephalography (MEG), as electroencephalography (EEG), electrocardiography (EKG), and others, can be seen as forms of medical imaging because they produce data susceptible to be represented as maps (i.e. containing positional information).

Biomedical Imaging technologies:

- Radiography
- Magnetic resonance imaging (MRI)
- Fiduciary Markers
- Nuclear medicine

- Photoacoustic imaging
- Breast Thermography
- Tomography
- Ultrasound
- Echocardiography

PET scanning

Positron emission tomography (PET) scanning, also a nuclear medicine procedure, deals with positrons. The positrons annihilate to produce two opposite traveling gamma rays to be detected coincidentally, thus improving resolution. In PET scanning, a radioactive, biologically active substance, most often 18F-FDG, is injected into a patient and the radiation emitted by the patient is detected to produce multiplanar images of the body. Metabolically more active tissues, such as cancer, concentrate the active substance more than normal tissues. PET images can be combined (or "fused") with an anatomic imaging study (currently generally CT images), to more accurately localize PET findings and thereby improve diagnostic accuracy. The fusion technology has gone further to combine PET and MRI similar to PET and CT. PET/MRI fusion, largely practiced in academic and research settings, could potentially play a crucial role in fine detail of brain imaging, breast cancer screening, and small joint imaging of foot. The technology recently blossomed following passing a technical hurdle of altered positron movement in strong magnetic field thus affecting the resolution of PET images and attenuation correction

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.

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.

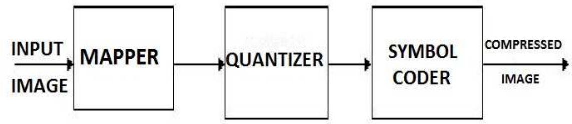


Figure 1 Image Compression model

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. These compression methods also 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

Discrete Cosine Transform

It involves expression of data points in finite sequence in terms of cosine function’s sum oscillating at different frequencies. DCT’s are important to numerous applications in science and engineering, from loosy compression of audio and images, to spectral methods for the numerical solution of partial differential equations. The use of cosine rather than sine function is critical in these applications. The cosine functions are much more efficient for compression(as described below, fewer functions are needed to approximate a typical signal), whereas for differential equations the cosines expresses a particular choice of boundary conditions. In particular, the DCT is a Fourier-related transform similar to the discrete Fourier transform (DFT), but using only

 ISSN: 2277-9655
Impact Factor: 1.852

real numbers. DCTs are equivalent to DFTs of roughly twice the length, operating on real data with even symmetry (since the Fourier transform of a real and even function is real and even), where in some variants the input and/or output data are shifted by half a sample. There are eight standard DCT variants, of which four are common.

The most common variant of discrete cosine transform is the type-II DCT, which is often called simply "the DCT",[1][2] its inverse, the type-III DCT, is correspondingly often called simply "the inverse DCT" or "the IDCT". Two related transforms are the discrete sine transform (DST), which is equivalent to a DFT of real and odd functions, and the modified discrete cosine transform (MDCT), which is based on a DCT of overlapping data.

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, instead of this it uses cosine function. DCT has some advantages over DFT as DCT is having better computational efficiency as it's a real transform system and moreover DCT does not produce discontinuity in the time signal in the process of periodicity. The most common discrete cosine transform definition of a one dimensional sequence of length N is given by the equation

$$F(u) = \left(\frac{2}{N}\right)^{\frac{1}{2}} \sum_{i=0}^{N-1} \Lambda(i).cos\left[\frac{\pi.u}{2.N}(2i+1)\right] f(i)$$

and the corresponding ***inverse*** 1D DCT transform is simple $F^{-1}(u)$, i.e.:
where

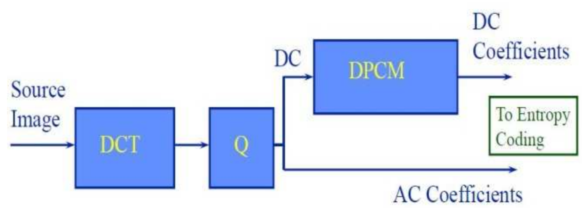
$$\Lambda(i) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for} \xi = 0 \\ 1 & \text{otherwise} \end{cases}$$

The general equation for a 2D (*N* by *M* image) DCT is defined by the following equation:

$$F(u,v) = \left(\frac{2}{N}\right)^{\frac{1}{2}} \left(\frac{2}{M}\right)^{\frac{1}{2}} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} \Lambda(i).\Lambda(j).cos\left[\frac{\pi.u}{2.N}(2i+1)\right] cos\left[\frac{\pi.v}{2.M}(2j+1)\right].f(i,j)$$

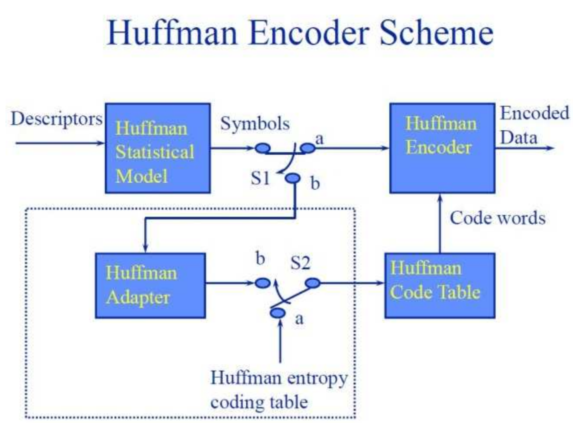
and the corresponding ***inverse*** 2D DCT transform is simple $F^{-1}(u,v)$, i.e.:
where

$$\Lambda(\xi) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for} \xi = 0 \\ 1 & \text{otherwise} \end{cases}$$



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. 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 0 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= $\sum_{K}^{L} P(a_1) \log P(a_j)$

Huffman decoding

The process of decompression involves the prefix codes stream translation to individual byte values, usually by reading each bit from input stream and traversing the Huffman tree node by node. The reconstruction of Huffman tree must take place for this process. Preconstruction of tree could take place in the case of predictable character frequencies and at the expense of at least some measure of compression efficiency, is reusable every time. Otherwise, tree reconstruction information is to be sent a priori. To prepend each character to the compression stream on the basis of frequency count a naive approach might be used. If thr canonical encoding is used in data compression then reconstruction of compression model can be done with just $B2^B$ bits of information (where number of bits are represented by B). One more way is to prepend Huffman tree to the output stream bit by bit. For example, 0 is assumed as the value representing a parent node and a leaf node is represented by 1, tree building routine reads the next 8 bits on encounter of latter for character value determination of particular leaf. Huffman tree is reconstructed on reaching last leaf node, until then the process continues. The decompressor must be able to determine when to stop producing output since the compressed data can include unused "trailing bits". By defining a special code symbol to signify the end of input or by either transmitting the length of the decompressed data along with the compression model , this can be accomplished.

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. Finally, the comparison of the images will be done with the correlation method to find the best similarity result of the images.

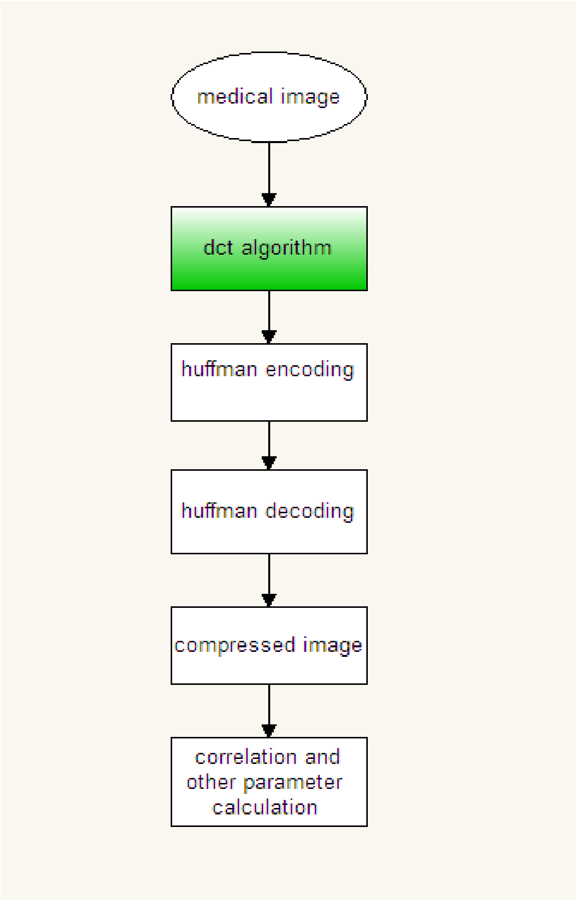


Figure 2.1 Steps of proposed method

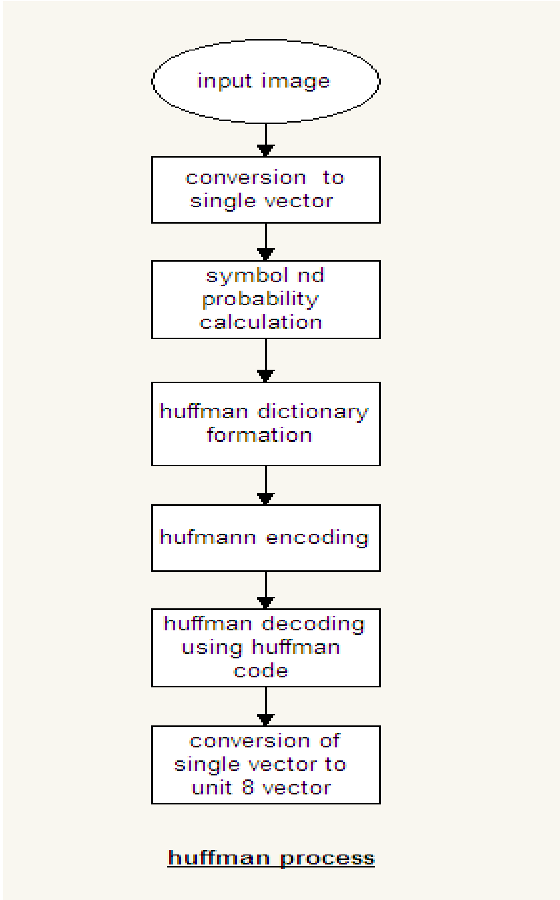


Figure 2.2 Huffman process

Huffmann algorithm steps

1) The output of DCT is taken as input in Huffman algorithm.
2) Dictionary formation using probability and symbol.
3) Huffmann encoding of the dictionary
4) Huffman decoding by using Huffman code and Huffman tree reconstruction.
5) Output as unit8 image.

Results

After experimentation we came across improved results with good Psnr value and less Mse value which shows utility of our compression process. Correlation comes out as 0.9986 which shows good correlation between the input image and output image after compression. Following are the results we get from our proposed scheme.

PSNR	*13.01*
MSE	*57.22*
Correlation	*0.9986*

Table 3.1 PSNR value, MSE value, correlation and compression ratio.

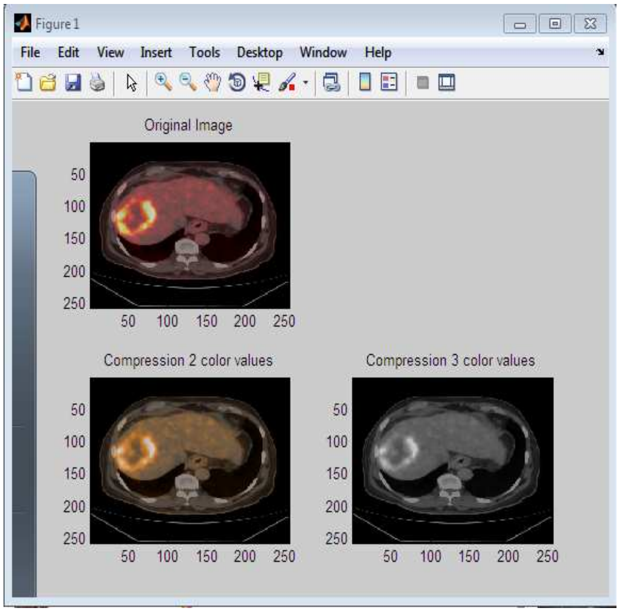


Figure 3.1 Image results after DCT process showing input image, 2 color compression and 3 color compression.

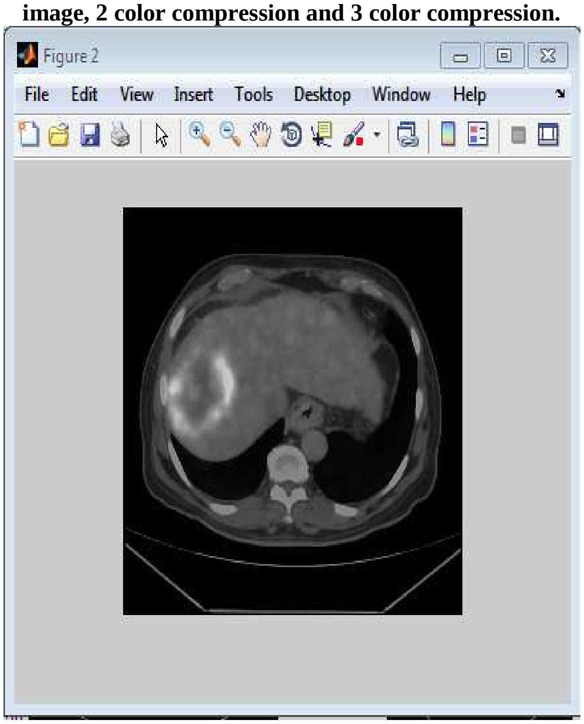


Figure3.2 Image results after Huffmann process

Conclusion

The paper shows the use of DCT process in combination with very fine process of Huffman encoding. Huffman process is basically for data encoding schemes but we used it with DCT to get good image compression results. The software is developed under Matlab mathematical platform that allows the efficient compression of the medical images. The correlation value shows similarity between images to a good extent which shows that our process is not only based on compression but also on maintaining proper quality of the images. Our main focus is to bring about compression in images without compromising its quality. Our technique will proved to be recent advancement in medical image compression.

References

[1] V.K. Bairagi1 A.M. Sapkal,''*Automated region-based hybrid compression for digital imaging and communications in medicine magnetic resonance imaging images for telemedicine applications*'', The Institution of Engineering and Technology, IEEE, 2012

[2] M Alpetekin Engin and Bulent Cavusoglu, IEEE communication letter, vol 15, no-11, November 2011, pg 1234-1237.

[3] Digital Image Processing using Matlab by Rafael C. Gonzalez & Richard E. Woods.

[4] Ruchika, Mooninder, Anant Raj Singh," *Compression of Medical images using Wavelet Transforms*", International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume -2, Issue-2, May-2012.

[5] Vaishali G. Dubey and Jaspal Singh, "*3D Medical Image Compression Using Huffman EncodingTechnique*" International Journal of Scientific and Research Publications, Volume 2, Issue 9, September 2012, ISSN 2250-3153.

[6] Syed Ali Khayam, "*DCT-Theory and Applications*", March 2003.

[7] D.A Huffman, "*A method for the construction of Minimum redundancy Codes*", Proc. IRE, vol.40, no.10, p.p. 1098-1101,1952.

[8] Jagadish H.Pujar, Lohit M. Kadlaskar, " *A new Looseless method of image compression and decompression usingHuffman coding techniques*", Journal of Theoretical and Applied Information Technology, JATIT.

[9] Lui zin et.al ,"*multiple digital watermarking algorithm to protect digital images based integer wavelet matrix norm quantization*",Chinese control and decision conference,2009.

[10] A. Haoui, D.C. Messerschmitt, "Predictive vector quantization," *Speech and Signal Processing*, vol. 1, pp.10.10.1–10.10.4, Mar. 1984

[11] N. Moayeri, D.L. Neuhoff, and W.E. Stark, "Fine coarse vector *quantization*," *IEEE Trans.*

ISSN: 2277-9655
Impact Factor: 1.852

Signal Processing, vol.39, no. 7, pp. 1503–1515, July 1991.

[12] Qiang Luo, John G.Harris et al, "*Adaptive Relative and Absolute Address Coding CMOS Imager Technique and System Architecture*" *United States Patent,* US 7071982B2, Jul 4th 2006.