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Survey on Medical Image Compression Using Contourlet Transform

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ABSTRACT

Medical image compression is essential nowadays for telemedicine application. Image compression is associated with removing redundant information and transmits required image data. To transmit large amount of data lot of techniques has been implemented in image compression. Image compression methods already implemented for normal images, one dimensional and 2D image. Recent work has been concentrated on medical images. BPC(BitPlane Coding) technique has been implemented in medical image compression. In this paper, presents a research overview of medical image compression using contourlet transform using wavelet transform, EBCOT algorithm and vector quantization, and its techniques with its future scenario.
Keywords : Medical image Compression, EBCOT, vector quantization, Image processing, Encoding, Wavelet Transform.

I. INTRODUCTION

Digital images require huge amounts of space for storage and large bandwidths for transmission. A 640 x 480 colour image requires close to 1MB of space. Image compression addresses the problem of reducing the amount of data required to represent a digital image. It is a process intended to yield a compact representation of an image, thereby reducing the image storage/transmission requirements.The goal of image compression is to reduce the amount of data required to represent a digital image. Reduce storage requirements and increase transmission rates. Compression is achieved by the removal of one or more of the three basic data redundancies:

i. Coding Redundancy
ii. Interpixel Redundancy
iii. Psychovisual Redundancy

i) Coding Redundancy:

Coding redundancy is present when less than optimal code words are used.

- Code: a list of symbols (letters, numbers, bits etc.)

ii) Inter pixel redundancy:

Interpixel redundancy results from correlations between the pixels of an image.

Interpixel redundancy implies that any pixel value can be reasonably predicted by its neighbours (i.e., correlated).To reduce interpixel redundancy, the data must be transformed in another format (i.e., through a transformation)

E.g Thresholding, differences between adjacent pixels, DFT.

iii) Psycho visual redundancy:

Psycho visual redundancy is due to data that is ignored by the human visual system (i.e. visually non essential information).

- The human eye does not respond with equal sensitivity to all visual information.
- It is more sensitive to the lower frequencies than to the higher frequencies in the visual spectrum.
- Idea: discard data that is perceptually insignificant!

A. Image Compression Model

Image compression techniques reduce the number of bits required to represent an image by taking advantage of these redundancies. An inverse process called decompression (decoding) is applied to the compressed data to get the reconstructed image.

Image compression systems are composed of two distinct structural blocks: an encoder and a decoder.

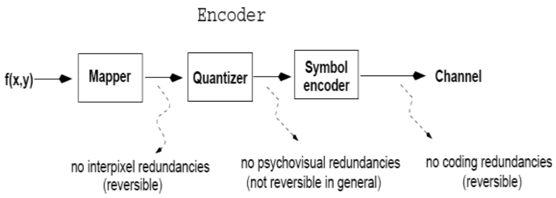

Fig1 Block Diagram for Encoder

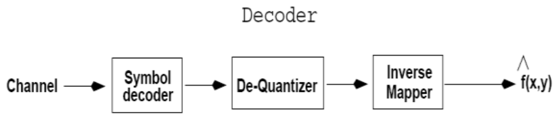

Fig 1.2 Block Diagram for Decoder

B. Image Compression Techniques

The image compression techniques are broadly classified into two categories depending whether or not an exact replica of the original image could be reconstructed using the compressed image. These are:

i). Lossless technique
ii). Lossy technique.

i) Lossless Compression

In lossless compression techniques, the original image can be perfectly recovered from the compressed (encoded) image. These are also called noiseless since they do not add noise to the signal (image).It is also known as entropy coding since it use statistics/decomposition techniques to eliminate/minimize redundancy. Lossless compression is used only for a few applications with stringent requirements such as medical imaging. Lossless compression is preferred for artificial images such as technical drawings, text and medical type images, icons or comics. Some of the techniques included in lossless compression are:

a. Run length encoding
b. Huffman encoding
c. LZW coding
d. Area coding

ii) Lossy Compression

Lossy schemes provide much higher compression ratios than lossless schemes. Lossy schemes are widely used since the quality of the reconstructed images is adequate for most applications. By this scheme, the decompressed image is not identical to the original image, but reasonably close to it. In lossy compression the recovered data is a close replica of the original with minimal loss of data. Lossy compression is used for signals like speech, natural images, etc. Lossy compression techniques include the following schemes:

a. Transformation coding
b. Vector quantization
c. Fractal coding
d. Block Truncation Coding

Metrics for evaluating compression algorithms

C. Quantitative measures

Two error metrics are often used to compare the original and the reconstructed image following the use of lossy image compression. These metrics are the mean square error (MSE) and the peak signal-to-noise ratio (PSNR).

The MSE and PSNR are routinely published in the literature and are frequently used to quantitatively compare lossy compression techniques. However, MSE and PSNR often do not correlate well with the subjective quality perceived by the human visual system.

D. Qualitative Measures

Receiver Operating Characteristic (ROC) analysis is used to measure the difference in perceived quality between the original and reconstructed image. Observers with expertise in diagnosing disease review a series of images of a disease that have been compressed to a predetermined ratio and then reconstructed. For each image, the observer assigns an ROC confidence rating on a predefined scale representing their impression of the likelihood the disease is present.

These results are compared with the diagnosis made from the original image. If the results are very close for both the original and the reconstructed image, then this can indicate an acceptable level of compression for this particular disease. A meaningful ROC analysis often requires many images (> 100) and several observers. Although this method is tedious and time-consuming, it is an accepted method in the radiology community for determining image quality based on visual perception.

Image compression may be lossy or lossless. Lossless compression is preferred for archival purposes and often for medical imaging, technical drawings, clip art, or comics. Lossy compression methods, especially when used at low bit rates, introduce compression artifacts. Lossy methods are especially suitable for natural images such as photographs in applications where minor (sometimes imperceptible) loss of fidelity is acceptable to achieve a substantial reduction in bit rate. Lossy compression that produces negligible differences may be called visually lossless.

The organization of this document is as follows. In Section 2 (**LITREATURE SURVEY**), I'll give detail of methods and Techniques used in various papers and also discussed the advantages and disadvantages. In Section 3 (**Future work**), based on the above discussion we have decided the research work. Discussed in Section 4 (**Conclusion**) Comparing the performance of various system.

II. LITERATURE SURVEY

To analyse various medical image compression techniques literature survey has been made.

Santhosh, B., &Viswanath, K. (2016). (pp. 531-537). Springer India.[1] system proposed a algorithm to reduce noise in medical images using contourlet transform. To prove the performance of contourlet transform two types of noises such as Gaussian noise and speckle noise added into an image.

F. Aulí-Llinàs, IEEE Trans. Multimedia, vol. 17, no. 8, pp. 1385–1390, Aug. 2015[2]

The system proposed an algorithm context-based Adaptive Binary Arithmetic Coding (CABAC) to compress video. It uses arithmetic coding and context modeling for providing reduction in redundancy and adaptation. The system proposes two algorithms FLW, FL2W. It simplifies implementation and reduces computational complexity.

F F. Aulí-Llinàs and M. W. Marcellin, IEEE Trans. Multimedia, vol. 16, no. 4, pp. 960–970, Jun. 2014 [3]

The system proposed parallel processing. In the existing system context adaptive arithmetic coding gives poor coding performance in spatial scalability, to enhance the performance it performs bit plane coding and stationary probabilistic model in parallel. The performance of proposed system is similar when the code block size is medium and Large, but it gives better performance if the code block size is small.

F. Aulí-Llinàs, M. W. Marcellin, J. Serra-Sagristà, and J. Bartrina-Rapesta Inf. Sci., vol. 239, no. 1, pp. 266–282, Aug. 2013[4].

The proposed system achieve parallelism implements bit plane coding code blocks given tostatistical probabilistic model to capture the statistical behavior of the image. This algorithm supports all types of 3-D images. An important aspect of this mathematical framework is its generality, which makes the proposed scheme suitable for different types of 3D images. The features of the proposed systems are competitive coding performance, low computational load, very low memory requirements, straightforward implementation, and simple adaptation to most sensors.

Francesc Aulı-Llinas, Pablo Enfedaque et al Proceedings of 2015 Data Compression Conference pp. 163-172 [5]

The system proposed microscopic parallelism it is achieved by multiple coefficient coded in parallel. Biplane coding coefficients are given to arithmetic coding. This system suitable for SIMD and MIMD processor.

P. Eben Sophia and J. Anitha Intelligent Decision Technologies 10 (2016)

The proposed system input is 3-D image. Image split into regions using prediction algorithm. ROI images coded using arithmetic coding and NROI coded using contourlet transform then the values coefficients of the transformed coefficients are normalized using mathematical approach and then the normalized value quantized using arithmetic coding. The performance of the system analysed by using a measure

Compression ratio (CR), Peak signal to noise Ratio(PSNR).Compression ratio of ROI is less compared to NROI. But the PSNR is high for ROI, low for NROI.

NehaMadhukumar, Sanchez V, Abugharb, ijarece,2015[7]

In this system input is a 3-D image given to contourlet transform the K-space is formed by using Fourier transform then 2-D random sampling applied to segment the image. Reconstruction is achieved by applying the reverse process.

Sanchez V, Abugharbieh R, Nasiopoulos P: IEEE Trans Med Imag (7):1062–1072,2009 [8]

A Several techniques based on the three–dimensional (3-D) discrete cosine transform (DCT) have been proposed for volumetric data coding. These techniques fail to provide lossless coding coupled with quality and resolution scalability, which is a significant drawback for medical applications. This paper gives an overview of several state-of-the-art 3-D wavelet coders that do meet these requirements and proposes new compression methods exploiting the quad tree and block-based coding concepts, layered zero-coding principles, and context-based arithmetic coding. Additionally, a new 3-D DCT based coding scheme is designed and used for benchmarking. The proposed wavelet-based coding algorithms produce embedded data streams that can be decoded up to the lossless level and support the desired set of functionality constraints. Moreover, objective and subjective quality evaluation on various medical volumetric datasets shows that the proposed algorithms provide competitive lossy and lossless compression results when compared with the state-of-the-art.

F. Aulí-Llinàs and J. Serra-Sagristà, IEEE Trans. Circuits Syst. Video Technol., vol. 18, no. 7, pp. 923–936, Jul. 2008[9].

Input is a 3-D image. In 3-d image transformation performed generates layered bit stream**. S**calability is achieved by using rate distortion optimization techniques. The performance is measured by comparing the quality of original image and reconstructed image.

T.-T. Wong, C.-S.Leung, P.-A.Heng, and J. Wang, IEEE Trans. Multimedia, vol. 9, no. 3, pp. 668–673, Apr. 2007.[10]

Image is processed by Discrete wavelet transform (DWT) it leads poor performance when compressing large volume of data. This system proposed to implement convolution based DWT. and this paper used SIMD algorithm to achieve parallel processing in a single processor.

M. N. Do, M. Vetterli, IEEE Transactions on Image Processing, no. 12, pp. 2091-2106, 2005[11]

Wavelet transform is multi resolution in nature**.** Apply 2-D transform to image it capture geometric structure for better visual information. To capture discrete nature by applying contourlet transform.

Srikanth R, Ramakrishnan AG: IEEETransMedImag24(12):1199–1206, 2005[12]

The system proposed mesh based coding for 3-D medical images.mesh based scheme removes irrelevant background and content based mesh finds optical flow between two spatial edges. The performance of this system is compared with uniform and adaptive mesh-based schemes. The proposed system performance is better than existing system.

III. FUTURE WORK

The emphasis of this paper is on lossless coding of 3-D MRI images, which is a primary requirement of our collaborators. However, the recent 3-D compression schemes for medical images provide important functionalities like region of interest coding and progressive transmission of images. The schemes also provide additional functionality of decoding 2-D images or any objects of interest from the 3-D encoded images. The current implementation of our work does not provide these important functionalities.

A future work the combination of the coefficients from both transforms into zero trees (representing the inter scale dependencies) will be studied. Future work involves compressing other types of medical images with this proposed system using parallel computing

IV. CONCLUSION

Input is an 3-D MRI image (Dicom or Bmp) then process the input image using contourlet transform. The 3D medical images decomposed into 2D slices and then given to Contourlet transform. It is a multi-resolution and directional decomposition of a signal using a combination of Laplacian Pyramid (LP) and a Directional Filter Bank (DFB). The LP decomposes images into sub bands and DFB analyses each detail image. The co efficients of the transform are then quantized using different quantization levels for each subband. Namely, more levels are assigned to important subbands and scales. The encoder takes an input vector and outputs the index of the codeword that offers the lowest distortion. In this case the lowest distortion is found by evaluating the Euclidean distance between the input vector and each codeword in the codebook. Once the closest codeword is found, the index of that codeword is sent through a channel (the channel could be a computer storage, communications channel, and so on). When the decoder receives the index of the codeword, it replaces the index with the associated codeword. Encode the image using vector quantization, then make reverse for decoding, for pre processing the image can use any technique

V. BENEFITS OF COMPRESSION

- Storage Space compressing data files allows one to store more files in the storage space that is available
- Bandwidth and Transfer Speed Compressed files contain fewer "bits" of data than uncompressed files, and, as a consequence, use less bandwidth when we download them.
- Cost of storing the data are reduced by compressing the files for storage because more files can be stored in available storage space when they are compressed. [8]
- Accuracy also reduces the chance of transmission errors since fewer bits are transferred [9].
- Security also provides a level of security against illegitimate monitoring [9].

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