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A Review: Modified Remove Redundancy Technique of Lossless Image Compression

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Abstract: Image compression is process to remove the redundant information from the image so that only essential information can be stored to reduce the storage size, transmission bandwidth and transmission time. The essential information is extracted by various transforms techniques such that it can be reconstructed without losing quality and information of the image. The purpose of image compression is the original large image with less bytes and transmission and required with good image recovery quality. The development of multimedia and digital imaging has led to high quantity of data required to represent modern imagery. This requires large disk space for storage, and long time for transmission over computer networks, and these two are relatively expensive. These factors prove the need for images compression. Image compression addresses the problem of reducing the amount of space required to represent a digital image yielding a compact representation of an image, and thereby reducing the image storage, transmission time requirements. The key idea here is to remove redundancy of data presented within an image to reduce its size without affecting the essential information of it.

Keywords: Lossless Image Compression; Discrete Wavelet Transform (DWT), Discrete Cosine Transform (DCT), compression ratio (CR), peak signal to noise ratio (PSNR).

I. INTRODUCTION

Data compression is the technique to reduce the redundancies in data representation in order to decrease data storage requirements and communication costs. Reducing the storage requirement is used to increasing the capacity of the storage medium and communication bandwidth. Redundancy different amount of data might be used. If the same information can be represented using different amounts of data and the representations that require more data than actual information is referred as data redundancy. Number of bits required to represent the information in an image can be minimized by removing the redundancy present in it. In this paper we analyze the methods of compressing images without degrading its quality. This is achieved through minimizing the number of bits required to represent each pixel. This reduces the amount of memory required to store images and facilitates transmitting image in less time. Image compression techniques fall into two categories: lossless or lossy image compression.

Lossless image compression is used to compress images in critical applications as it allows the exact original image to be reconstructed from the compressed one without any loss of the image data. Lossy image compression suffers from the loss of some data. Thus, repeatedly compressing and decompressing an image results in poor quality of image.

Compression is achieved by removing one or more of the three basic data redundancies: Coding redundancy, which is presented when less than optimal code words are used. Inter pixel redundancy, which results from correlations between the pixels of an image. Psycho visual redundancy is that which is ignoring by the human visual system. So, image compression becomes a solution to many imaging applications that require a vast amount of data to represent the images, such as document imaging management systems, facsimile transmission, image archiving, remote sensing, medical imaging, entertainment, HDTV, broadcasting, education and video teleconferencing. One major task that faces lossless image compression is how to protect the quality of the image in a way that the decompressed image appears identical to the original one by removing redundancy.

Techniques

Data compression can be understood as a method that takes an input data D and generates a shorter representation of the data c(D) with less number of bits compared to that of D. The reverse process is called decompression, which takes the compressed data c(D) and generates or reconstructs the data D‟. Sometimes the compression (coding) and decompression (decoding) systems together are called a "CODEC".

a. Data Compression Model:

The popular techniques used in the redundancy reduction step are prediction of the data samples using some model, transformation of the original data from spatial domain such as Discrete Cosine Transform (DCT), decomposition of the original data set into different sub bands such as Discrete Wavelet Transform (DWT), etc. In principle, this

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step potentially yields more compact representation of the information in the original data set in terms of fewer coefficients or equivalent. In case of lossless data compression, this step is completely reversible. Decompression system produces the exact replica of the original data and hence the compression system can be called a lossless compression system.

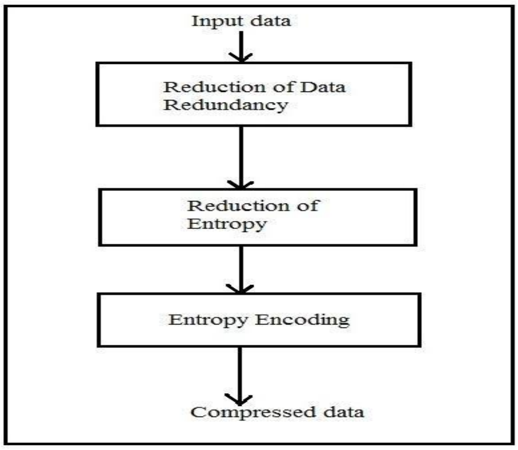


Figure 1: Data compression model

b. Image compression techniques

Run-length encoding (RLE) is a simple approach to source coding when there exists a long run of the same data, in a consecutive manner, in a data set. As an example, the data d = (5 5 5 5), (19 19 19) contains long runs of 5"s, 19"s etc. Rather than coding each sample in the run individually, it represent compactly. A variation of this technique is applied in the baseline JPEG standard for still-picture compression.

Huffman coding technique is invented to produce the shortest possible average code length given the source symbol set and the associated probability of occurrence of the symbols. Codes generated using these coding techniques are popularly known as Huffman codes.

Arithmetic coding is a variable-length source encoding technique. In arithmetic coding a sequence of input symbols is represented by an interval of real numbers between 0.0 and 1.0. The longer the message, the smaller the interval to represent the message becomes. More probable symbols reduce the interval less than the less probable symbols and hence add fewer bits in the encoded message.

Discrete Cosine Transform (DCT) represents an image as a sum of sinusoids of varying magnitudes and frequencies. Discrete Cosine Transform (DCT) attempts to decor-relate the image data. After decor-relation each transform coefficient can be encoded independently without losing compression efficiency. The DCT transforms a signal from a spatial representation into a frequency representation. DCT has the ability to pack most information in fewest coefficients. It provides the PSNR of 25db but compression ratio is less.

Discrete Wavelet Transform (DWT) represents an image as a sum of wavelet functions, known as wavelets, with different location and scale. It represents the data into a set of high pass (detail) and low pass (approximate) coefficients. The DWT allowing image multi resolution representation and progressive transmission, rate scalability DWT offers higher efficiency in term of quality of compressed image and compression ratio but PSNR up to 23db. DCT & DWT both are transforming based techniques & widely used to remove data redundancy.

II. LITERATURE REVIEW

[1] Archana Deshlahra, "Analysis of Image Compression Methods Based On Transform and Fractal Coding", 2013
In this thesis analysis of various Image compression techniques for different images is done based on parameters, compression ratio(CR), mean square error (MSE), peak signal to noise ratio (PSNR). Our simulation shows that we can achieve higher compression ratio using hybrid technique. DWT gives better compression ratio without losing more information of image. Pitfall of DWT is that it requires more processing power. DCT overcomes this disadvantage since it needs less processing power, but it gives less compression ratio. DCT based standard JPEG uses blocks of image. Block boundaries are noticeable in some cases. Hybrid transform gives higher compression ratio but for getting that clarity of the image is partially trade off. It is more suitable for regular applications as it is having a good compression ratio along with preserving most of the information. On the other hand Fractal Image Compression gives a great improvement on the encoding and decoding time. A weakness of the proposed design is the use of fixed size blocks for the range and domain images. This type of compression can be applied in Medical Imaging, where doctors need to focus on image details, and in Surveillance Systems.

[2] Hui Zha, "Progressive Lossless Image Compression Using Image Decomposition and Context Quantization, 2007
In this thesis, an efficient lossless image compression algorithm for both the binary images and gray-scale images is developed. Lossless image compression has extensive application in medical imaging, space photographing and film industry to archive and transmit images. To efficiently compress images, we first decompose images to reduce encoding symbols. The benefits lie in four aspects. First, the progressive image transmission is achieved by image decomposition. Second, the encoding alphabet is reduced to the binary alphabet. Third, decomposition provides an opportunity to use those partial future" information of non-causal pixels to help encoding. Finally, the decomposition provides a straight-forward way to encode bi-level images, considering that current gray-scale image compression algorithms usually

have bad performance on bi-level images. To deal with the well-know context dilution problem, we propose a Lloyd-like context quantization algorithm which refines the context mapping to minimize the compression rate.

[3] Zhang Ning, "Study On Image Compression And Fusion Based On The Wavelet Transform Technology", International Journal On Smart Sensing And Intelligent Systems Vol. 8, No. 1, March 2015.
With the development of information technology, the rapid development of microelectronics technology, image information acquisition and use is also increasing sensor technology also unceasingly to reform. Single sensor information obtained is limited, in addition, different sensors have the advantage of the imaging principle and its unique as in color and shape characteristics, band access and spatial resolution from the aspects of all have their own characteristics. Registration algorithm is proposed in this paper has better robustness to image noise, and can achieve sub-pixel accuracy. This paper based on the introduction of the principle of wavelet analysis and its application in image compression coding on the proposed an improved SPIHT algorithm. The fundamental of standard SPIHT algorithm is the quantization of the wavelet coefficients, the standard SPIHT algorithm adopted quantitative two into interval fixed, without considering the features of energy distribution of the wavelet coefficients. The SPIHT algorithm the algorithm than the standard encoding and decoding times greatly reduced time consumption and PSNR and the standard SPIHT algorithm is quite.

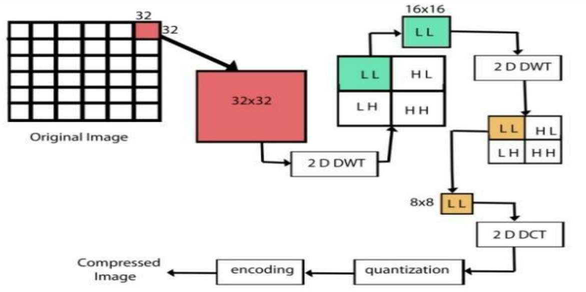
[4] ARUN KUMAR, "Implementation of Image Compression Algorithm using Verilog with Area, Power and Timing Constraints"
An image compression algorithm was simulated using Matlab to comprehend the process of image compression. Modifications on the padding style showed reduction in the error, because it offers a better reproduction of image at its edges. It keeps the size of the transform coefficient matrix equal to the image size. For the VLSI implementation of an image compression encoder, Verilog HDL was chosen. Understanding the importance of the multiplier in implementing a Discrete Wavelet Transform (DWT), fixed-point 16-bit signed Booth Multipliers were implemented in Verilog HDL for different architectures and a thorough analysis in terms of time; power and area were carried out. Finally the Booth Multiplier architecture using 17-bit Carry Save Adder for adding partial products and a 31-bit Ripple Carry Adder for adding pseudo sum and carry vector was selected to perform the multiplication operation in DWT.

III. OBJECTIVES

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. In Hybrid transform we are proposing a transform technique that will exploit advantages of DCT and DWT to get compressed image. DCT represent an image as a sum of sinusoids of varying magnitudes and frequencies. The DWT represents an image as a sum of wavelet functions, known as wavelets, with different location and scale. Hybrid transform approach is combination of DCT & DWT. This combined effect of DCT and DWT improves the quality of reconstructed image. Hybrid transformation gives more compression ratio compared to JPEG and JPEG2000, preserving most of the image information and create good quality of reconstructed image. Hybrid (DCT+DWT) Transform reduces blocking artifacts, false contouring and ringing effect and remove the redundancy.

IV. PROPOSED METHODOLOGY

Compression procedure
The input image is first converted to gray image then divided into size of 32x32 pixels blocks. 2D-DWT applied on each block four details is produced. Out of four sub band details, approximation sub band is further transformed again by 2 D-DWT which gives another four sub-bands of 16x16 blocks. Above step is followed to decompose the 16x16 block of approximated detail to get new set of four details of size 8x8. The level of decomposition is depend on size processing block obtained initially and divide image initially into size of 32x32, hence the level of decomposition is 2D-DCT. After getting four blocks of size 8x8, we use the approximated details of DCT coefficients. These coefficients are then quantize and send for coding. The four bands approximate band (LL), Vertical Band (LH), Horizontal band (HL), and diagonal detail band (HH) are obtained. Figure shows the compression process and the reverse is decompression process.



Hybrid Compression Process

Decompression procedure
At receiver side, we decode the quantized DCT coefficients and compute the inverse two dimensional DCT and de-quantized each block. Further we take inverse wavelet transform of the de-quantized block. We arrange all blocks to get reconstructed image. The hybrid DWT-DCT algorithm has better performance as compared to stand alone DWT and DCT in terms of Peak Signal to Noise Ratio (PSNR) and Compression Ratio (CR). The contouring effect of DCT has also been reduced by using hybrid algorithm. PSNR is a measure of the peak error

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expressed in terms of the logarithmic decibel scale in (dB). Higher value of PSNR is good. Here, a signal represents original image and noise represents the error in reconstruction.

(a) Original image (b) PSNR=25.98db(c) PSNR=23.42db (d) PSNR=30.41db
DCT DWT HYBRID
Figure shows the PSNR value of three techniques.

It is the ratio between the maximum possible power of a signal and the power of the corrupting noise. PSNR decreases as the compression ratio increases for an image. PSNR is computed by measuring the pixel difference between the original image and compressed image. PSNR of hybrid transform is good i.e. 30.41db .Compression ratio is 89.28% in this technique.

V. CONCLUSION AND FUTURE WORK

This paper was motivated by the desire of improving the effectiveness of lossless image compression by improving the DCT and DWT. We can achieve higher compression ratio using Hybrid technique. DWT gives better compression ratio. DCT needs less processing power and DCT based standard facilitates progressive transmission of the image. This combined effect of DCT and DWT improves the quality of reconstructed image and removes the data redundancy in hybrid transform. It is concluded that the higher data redundancy helps to achieve more compression. It is more suitable for regular applications as it is having a good compression ratio along with preserving most of the information. The results clearly depicts that the value of PSNR for all the images stored in the set of dataset is high after compression in compare to the value of before compression which is quite good, reliable and scalable for data storage and removes the data redundancy. The ultimate goal is to give a relatively good compression ratio and keep the time and space complexity minimum.

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