A Survey on Image Compression Techniques

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Abstract— Medical images are compressed before storage and transmission because of the bandwidth and storage limitations. After compression the redundancy and irrelevance of image data is reduced without affecting the quality of the image. The compression of images allows more images to be stored memory. The time required to send the images over the internet and download from the web pages are also be reduced. There are different ways for compressing the images. Each techniques has its own advantages and disadvantages. Image compression also provides a level of security against illicit monitoring.

Keywords— Image Compression, Discrete Cosine Transform, Discrete Wavelet Transform, Anamorphic Stretch Transform, Real Fourier Transform, Discrete Fourier Transform**.**

INTRODUCTION

Image compression is used to minimize the size without affecting the quality of the image. The reduction in the size of image allows more image to be stored in the disk or given memory space. The compression techniques reduces the size of data that requires less bandwidth and less transmission time and related cost. The best image quality at a given bit rate or compression 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. The two common compressed graphic image formats are the JPEG format and the GIF format for internet use. JPEG method is used for photographs and the GIF method is used for line art and other images in which geometric shapes are relatively simple.

A text file or program can be compressed without the introduction of errors. It is crucial that compression be lossless because a single error can seriously damage the meaning of a text file, or cause a program not to run. In image compression, a small loss in quality is usually not noticeable. There is no “critical point” up to which compression works perfectly, but beyond which it becomes impossible. When there is some tolerance for loss, the compression factor can be greater than it can when there is no loss tolerance. For this reason, graphic images can be compressed more than text files or programs. The commonly used algorithms for the compression of Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT) etc.

Discrete cosine transform is an orthogonal transformation that is used in image compression. The use of cosine is critical for image compression. DCT is similar to discrete fourier transform. A discrete cosine transform express a sequence of data points in terms of sum of cosine functions oscillating at different frequencies. It helps to separate the image into parts with respect to the image’s visual quality. DCTs are equivalent to DFTs of roughly twice the length, operating on real data with even symmetry where in some variants the input and/or output data are shifted by half a sample.

Discrete wavelet transform (DWT) is a wavelet transform in which the wavelets are discretely sampled. An advantage of DWT is temporal resolution because it captures both frequency and location information. It is a linear transformation that operates on a data vector whose length is an integer power of two and transforming it into a numerically different vector of the same length. The main feature of DWT is multiscale representation of function. Using the wavelets a given function can be analyzed at various levels of resolution. The DWT is also invertible and can be orthogonal. Wavelets are effective for analysis of textures that recorded with different resolution. It is very important problem in nuclear magnetic resonance imaging because high-resolution images require long time of acquisition. This causes an increase of artifacts caused by patient movements which should be avoided.

Another technique for the compression of images is Anamorphic Stretch Transform (AST). AST is a physics based transform that emerged from photonic time stretch and dispersive fourier transform and can be applied to analog temporal signals such as communication signals and digital data such as images. It reshapes the data such that its output has properties conducive for data compression and analytics and the reshaping consists of warped stretching in fourier domain. The compression is lossless and is achieved through a same domain transformation of the signal's complex field and performed in the analog domain prior to digitization. AST can be used as a standalone algorithm or can be combined with existing digital compression techniques to enhance speed or quality or to improve the amount images can be compressed.

AST can also be used in analog applications because it can capture and digitize signals that are faster than the speed of the sensor and the digitizer and also minimizes the volume of data generated in the process.

COMPRESSION TECHNIQUES

H. B. Kekre et al. [4] proposed a new image compression technique using Real Fourier Transform. Matrix column transform, row transform and full transform is obtained from the image. Low energy coefficients are eliminated after transformation to represent the image in lesser number of bits. This technique gives perceptible image quality.

D. Malarvizhi et al. [6] proposed a new entropy coding algorithm for the compression of images using discrete co-sine transform. This algorithm uses quantized coefficients of discrete cosine transform. Image transformation, quantization and encoding are the main steps in compression. Inverse transformation dequantization and decoding are the steps in reconstruction. An N X M image is taken and the intensity of pixels are calculated. DCT coefficients of the images are generated using dct matrix. The pixels in the array are in the form of gray scale level. This algorithm also provides good quality images.

Ruchika et al. [5] proposed a compression algorithm based on the wavelet transforms. For compression, the wavelet coefficients of the image is generated for the desired levels and the numbers of levels are decided by the entropy of the image. A threshold for the coefficients of the image is selected and the coefficients below the threshold are taken as zero. Huffman encoding is used to reduce the redundancy in the coefficient data. The thresholded and huffman encoded coefficients are saved instead of the image. For reconstruction, huffman decoding is used. Image is reconstructed from the threshold coefficients by taking inverse discrete wavelet transform (IDWT). This algorithm has high decorrelation and energy compaction efficiency.

Vijendra Babu et al. [7] proposed a wavelet based image compression using region of interest (ROI) embedded zerotree wavelet (EZW). This algorithm is capable of coding each arbitrary shape ROI regions independently. In this case, region-based coding for better utilization of the available bit rate since the high quality should be maintained only for the aforementioned diagnostically significant regions and the rest of the image can be encoded at a lower bit rate. Once the region of interest is selected efficiently, the significant region is transformed using lossless integer wavelet transform filter and diagnostically unimportant region with lossy Daubechies 5/3 tap filter. Then the transformed images are encoded using Partial EZW algorithm. Arithmetic encoder is used to reduce the redundancy and to improve the efficiency of compression. The procedure for decoding is exact reverse of the encoding.

Andras Cziho et al. [8] proposed a technique for image compression using region of interest vector quantization. The algorithm is based on the vector quantization and adopts the idea of region of interest. The image to be compressed is first segmented into regions and a separate codebook is used for compressing every region. The size and the number of codewords may be different in the codebooks according to the diagnostic importance of the corresponding image region. This permits to create appropriate codebooks with representative codewords and to obtain good reconstruction quality in relevant zones, while reinforcing the compression in less important regions. The reconstructed image has good quality. Not only a good rate or distortion performance is obtained, but the quality is preserved.

Deepak Kumar Jain et al. [2] proposed a technique for image compression using discrete cosine transform and adaptive huffman coding. The original image is divided into blocks. DCT is applied to each block by multiplying the modified block with DCT matrix on the left and transpose of DCT matrix on its right. Each block is then compressed through quantization. A quantization matrix is used in combination with a DCT coefficient matrix to carry out transformation. Quantization is the step where most of the compression takes place. Quantized matrix is then entropy encoded. The compressed image is reconstructed through reverse process i.e., by using inverse DCT. This technique has good performance as compared to other algorithms.

Tanima Dutta [1] proposed a new technique for the com-pression of images. Image transformation and encoding of coefficients are the main steps in this compression. Color space conversion from RGB to YCBCR is used for the efficient transformation. The image is divided into non-overlapping blocks to decrease the number of operations. The conversion of progressive pixel scan to block-wise order is required to operate on small non-overlapping image blocks. Large block size can attain significantly compressed data for the consequent coefficients of small magnitude but may cause visual distortions. The image is transformed using integer discrete cosine transform (IntDCT). The transformed coefficients are then quantized using quantization matrix. After transformation the coefficients are encoded. The coefficients of a block are partitioned into DC and AC coefficients and the DC coefficients are differentially encoded. The differentially encoded DC coefficients are further encoded using Adaptive Golomb Rice (AGR) code that uses adaptive coding and requires only one pass through the data. The majority of high frequency AC coefficients are quantized to zero because of the energy compaction property of IntDCT. The remaining nonzero coefficients in a block are typically low frequency coefficients clustered around the DC coefficient. The AC coefficients in are scanned along a zigzag order. The encoder proposed to encode AC coefficients uses the principle of the zero run-length encoding.

Eleftherios Kofidis et al. [9] proposed a wavelet based image compression. The compression scheme is composed of a wavelet decomposition in conjuction with a modern quantization algorithm and a lossless entropy encoder. The quantization module is based on the embedded zerotree wavelet (EZW) algorithmic scheme, which constitutes the state of the art in wavelet based compression. The main features is the exploitation of the characteristics of the wavelet representation to provide a sequence of embedded compressed versions with increasing fidelity and resolution, thus leading to a particularly efficient solution to the problem of progressive transmission (PT). Arithmetic coding is used for encoding the coefficients. This technique is powerful and cost effective.

Mohammad H. Asghari et al. [3] proposed a method for image compression using anamorphic stretch transform. This technique is combined with the JPEG algorithm. The image is transformed using anamorphic stretch transform. After the transformation the reshaped image is uniformly re-sampled at a rate below the Nyquist rate of original image. The reshaping is such that it increases the spatial coherence. Therefore the sub-Nyquist resampling does not cause loss of information. In the decoder side, phase discrimination is used to recover the original image.

CONCLUSION

The enormous requirements concerning data rate and storage capacity can be reduced by lossless and lossy modes of image compression. Compression can also reduce the transmission time. The image compression is composed of an encoder and a decoder. Compression of the image is performed by the encoder and the decoder performs the decompression. The DCT-based image coders perform fine at moderate bit rates, at higher compression ratios, image quality degrades due to the artifacts. The DWT based compression provides good image quality as compared to DCT. Anamorphic stretch transform has good performance and provides good image quality than the DCT and DWT.

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