Removing Coding and Inter Pixel Redundancy in High Intensity Part of Image

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Abstract :

This paper presents a novel lossless image compression algorithm that is carried out by removing coding and inter pixel redundancy in high intensity part of image . Initially a input image is segmented into high and low intensity part of which only high intensity part of the image is considered. Three different kind of image compression algorithms are applied to the high intensity part and the results are compared. Image compression performance parameter like Compression Ratio (CR),Bits Per Pixel(BPP),Peak signal to Noise Ratio(PSNR) are evaluated to analyze the compression performance.

Keywords : Compression; High intensity; DCT; variable block size; SVD ;Biorthogonal;

1. Introduction

Image compression is the application of data compression on digital images. First international compression standard for continuous – tone images was developed by Join photographic Experts Group(JPEG)[14] . Summary work can be found in [1]. The main objective of compression is to reduce the redundancy in an image so that it can be transmited in a faster manner.

The two major classifications of compression are :

1. Lossles
2. Lossy

Image compression finds application in many areas like remote sensing, radar , sonar ,medical image, art work, broad cost television and teleconferencing .

2. History

Compression is achieved by removal of one or more of the three basic data redundancies.

֍coding redundancy
֍.Inter pixel redundancy
֍.Psychovisual redundancy

Coding redundancy means assigning fewer bits to the more probable gray levels than to the less probable one. This process is commonly known as variable length coding. The gray levels of an image are coded in a way that uses less code symbols to represent each gray level.

Inter pixel redundancy means predicting the value of any given pixel can be reasonably predicted from the value of its neighbors. This method assumes that the information carried by individual pixels is relatively small [4].

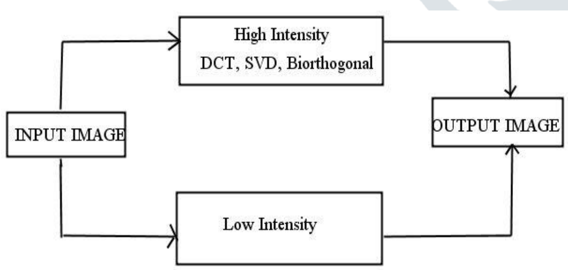
Psycovisual redundancy means identifying certain information is less important than others in normal visual processing. It can be eliminated without significantly impairing the quality of image perception. Since elimination of phycovisual redundant data results in a loss of quantitative information, it is commonly referred to as quantization.

3 . Literature Survey

As per Paul G.Howard & Jeffrey S.Vilter [2] , A new Fast Efficient Lossless Image Compression (FELICS) is proposed, which combine arithmetic encoding & golomb codes. FELICS is 26% better than Huffman coded JPEG & 12% better than arithmetic coded JPEG. Complexity of this technique is memory management problem. Meyar [5] have proposed a novel scheme Two way Mixing Model(TMW) for image compression. It consists of two stages one is coding and another one is analysis stage . Analysis stage consists of linear predictor parameter of images and these information is also passed to the coding stage. TMW uses multiple probability distribution because inter relationship of each pixel is different from different part of the image , so choosing only one parameter is unsuitable. It provides better result than Context based adaptive Lossless Image Codec(CALIC) [3].Xin Li[7] proposed edge based prediction (EDP) technique in 2001. It including Least Square bases[6] method for processing image in the way of edge by edge basis. Main advantage of this technique is no need to predict the edge orientation. As per Ichiro matsuda[10], In this paper , a novel approach is described to digital image compression using a quad tree based decomposition. Quad tree processing is recursive partitioning of square block into four sub blocks. It provides better result than TMW. As per Firas A.Jassim [11], In this paper , the implementation of a new compression methodology, which converted every pixels into multiples of five and divide by 5. This transformation will not be noticed by Human Visual System (HVS) and also reduced pixel variation. The results are compared with the results obtained from JPEG. The empirical results on standard test images provides higher PSNR than JPEG, which strengthen the idea of using FJPEG instead of JPEG in order to get lesser bits to represent more prominent features. Seyum kim & Nam IK Cho [8] , have proposed algorithm of hierarchical decomposition & pixel prediction method. Compression is achieved by means of Reversible Color Transform (RCT)[15]. Based on the characteristic of hierarchical decomposition, thay proposed compression scheme by applying RCT into input image. In this scheme, color input image is first translated by YCbCr and then chrominance of image is decomposed into two sub images. At last adaptive arithmetic encoding is introduced to encode model parameter of RCT. As per H.Asghari [12], a new physics based transformation technique for image compression is proposed which combine anamorphic transform & vector quantization encoding. In order to benefit from the advantages of each, We exploit physics based transform by reducing the bandwidth and spatial intensity. At last the compressed image is also compressed by using secondary compression technique that is JPEG 2000. K.Siva Nagi Reddy et al [9] have proposed algorithm of fast curvelet transform. In the past few years, wavelets and related multi scale representations provide signal processing [21], [22],[23]. Benefits of wavelets are allow us to detect roughly isotropic features occurring at all spatial scales and locations. The fast curvelet with modified SPHIT is low computational complexity and the computational speed of the algorithm is very good than the wavelet based schemes. As per Nadia Baziz et.al [13], The goal of this paper is to implement a set of pyramid transforms in an hierarchical approach for real television sequence which consists on a 3-D data information set.

4. System Architecture

Fig 1 : Architecture diagram



Firstly, the image is divided into high and low intensity pixels. The high intensity pixels are encoded using three different methods and the low intensity pixels are left as such. After decoding the high intensity pixels, the low intensity pixels are synthesized to get the output image. The methods discussed in Algorithm applied section are used for compressing high intensity pixels. Here, the image is not segmented, only the pixel values are sent for compression.

The overall system architecture is shown in Fig.1 Initially, the input image is divided into low and high intensity components. The high intensity components are compressed while the low intensity components are left as such. The decompressed low intensity components are combined with high intensity components to get the reconstructed output image. The proposed method uses three different methods to compress low intensity components. They are: DCT, SVD, Biorthogonal techniques.

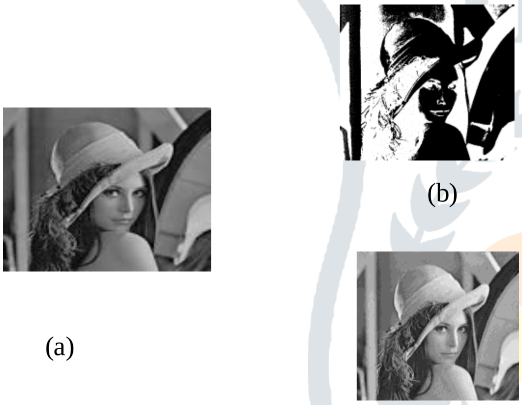
5. Algorithm Applied :

5.1 DCT

The Discrete Cosine Transform (DCT) is widely used in image ,video coding & high correlated data. [16,17,18,19]. DCT separate images into parts of different frequencies where less important frequencies are discarded through quantization & most important frequencies used to retrieve the image during decomposition.

5.1.1 DCT have many advantages

- It has been implemented in single integrated circuit.
- It has the ability to save more information in a fewest coefficients.
- It minimizes the block like appearance called blocking artifact that results when boundaries between sub images become visible [20]



(b)

(a)

©

Fig : 2 (a) Input lena (image 512X512) (b)intermediate result (c) compressed image

image coding, the image is divided into blocks which usually have a size of 8 by 8 pixels. For each of these blocks the DCT is calculated, which is given by:

$$X_c(k,l) = \tfrac{2}{N} C(k) C(l) \sum^{N-1} \sum^{N-1} x(m,n) \cos\left(\tfrac{(2m+1)\pi k}{2N}\right) \cos\left(\tfrac{(2n+1)\pi l}{2N}\right),$$

in—0 n=0

where *x(m,n)* is a block in the original image, *X (k,l)* is the transformed block, and *N* the size of the block. The next step is the quantization of the coefficients, which means that the coefficients are mapped onto a discrete set of values.This process is irreversible and leads to the quantization error *bX (k,l),* which is given by:

$$\Delta X_c(k,l) = \tilde{X}_c(k,l) - X_c(k,l)$$

where *,(k , f)* is the quantized value of *X (k,l).* *be* quantization is usually followed by a Variable Length Coder (VLC), which uses entropy coding to encode the quantized values. Entropy coding is lossless and has no influence on the spatial noise distribution, and therefore it will not be considered in this paper. In the decoder, the inverse DCT is applied to the blocks, which leads to the quantization error in the spatial domain.

5.2 Singular value decomposition (SVD)

It is purely linear techniques uses karhunen_Loeve Transform . Singular value Decomposition which allows us to refactoring a digital image in three matrices. It represent a image into smaller set of values, which can preserve useful features of the original image & keep less storage space in memory. SVD uses in face recognition also.

5.3 SVD Technique

Singular Value Decomposition (SVD) has been widely implemented in image processing. When image is considered as a matrix having a low rank, SVD can be implemented to approximate this matrix to represent much more compactable matrix than original image. More specifically, suppose we are given an image A which we will assume for simplicity is an $N \times N$ real matrix. SVD representation is give by

$$A = U\Sigma V^T$$

Compression is obtained from the value r columns of U, r rows of V, and $r \times r$ submatrix of Σ. The size of the representation is given by $r(d+1)$

where d is the sum of the dimensions of the matrix X. This representation will be good if X has low rank. It can only be achieved if the columns of X are similar.The images in the ensemble are columns of the image in case of SVD, adjacent column to be similar. Notice however, that this similarity drops off as the distance between the columns increases. In case of SVD, the corresponding points on the columns can be as far apart as N = n. Compressed image degrade the quality of the image which needed to be investigated. Root mean square error (RMSE) corresponds to pixels in the reference where Σ is a diagonal matrix with entries along the diagonal **image** I_r and the fused image I_f . If the reference ordered in a non-increasing order, and U ,V are orthogonal **image** and fused image are alike give the RMSE matrix [].Then a rank r approximation to A is the matrix is given by

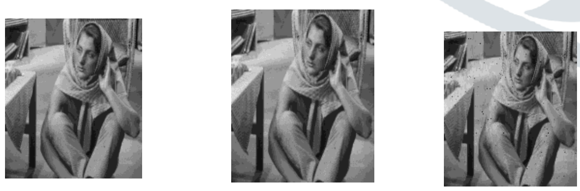
$$A_r = U\Sigma V^T_r$$

value equal to zero and it will increase when the dissimilarity increases between the reference and fused image [10].

5.4) Bi orthogonal

Bi orthogonal wavelets have most of the qualities of orthogonal wavelets; with the advantage of being more flexible. There are m any more bi orthogonal wavelets than orthogonal ones. For these reason, they make possible a variety of design options & constitute class of wavelets most used in practical applications. Bi orthogonal wavelets can have symmetry. They are associated with perfect analysis/reconstruction filter banks. Bi orthogonal wavelets constitute a generation of orthogonal wavelets

6. Experimental Results



(a) (b) (c)

Fig :3 compressed images (a)DCT (b) SVD c) Biorthogonal

Barbara image is purposely chosen as the test image, since it contains more detailed information which helps in the measure of the subjective evaluation of the quality of the reconstructed images using the proposed and existing methods. It is observed from the figure 3(b) that suffer from more pronounced blocking artifacts. Though the effect of blocking artifacts is reduced using bi orthogional (fig3(c)). It is observed that this method suffers from smoothening effect and hence ignoring the detailed information . DCT encoding (Fid 3 (a)) eliminates blocking artifacts , preserves details thereby improving the psycho visual quality in reconstructed image.Bi orthogonal provides better PSNR, and CR than other two techniques.

Table 1 : comparisons of DCT,SVD and bi orthogonal

Image	size	DCT			Singular value decomposition			Biorthogonal		
		CR	BPP	PSNR	CR	BPP	PSNR	CR	BPP	PSNR
Cman.tif	256X256	2.7120	2.9499	31.3975	3.4201	2.3391	27.3274	2.4153	3.3123	53.6704
Baboon.tif	256X256	1.9040	4.2017	35.4460	2.1312	3.7538	30.3937	2.0577	3.8879	54.7389
Barbara.png	512X512	1.5530	5.1513	30.8394	1.6721	4.7845	28.6364	1.6279	4.9142	56.0489
Boat.gif	512X512	2.5928	3.0855	30.0763	3.2848	2.4355	28.1392	3.0163	2.6522	53.4605
Lena.png	512X512	1.9893	4.0215	33.2852	2.2857	3.5000	30.6399	1.4522	5.5087	56.9466
Lifting.png	256X256	3.4951	2.2889	37.4194	5.0343	1.5891	32.3661	4.4600	1.7937	52.7471
Peppers.png	512X512	1.7385	4.6016	33.8769	1.9230	4.1602	30.9003	1.8587	4.3040	54.9235
Barbara.tif	256X256	1.5603	5.1271	41.0264	1.6669	4.7994	33.7897	-	-	-
Lena.tif	256X256	1.4047	5.6951	43.2319	1.4700	5.4420	33.8144	-	-	-
Lifting.png	512X512	3.4620	2.3108	33.3191	5.1474	1.5542	31.4915	-	-	-

Table 1 shows the comparison of results between the performance of the three schemes. Among the three methods BiOrthogonal Provides the better result than DCT and SVD for high Intensity Pixels. DCT gives reconstructed lena image with a PSNR value 33db, bit rate of 4.02 bpp and compression ratio is 1.98. The bi orthogonal gives less distorted reconstructed lena image with higher PSNR value 56db at a bit rate of 5.50 bpp and compression ratio is 1.45. Obviously, the biorthogonal gives a better PSNR and compression ratio than others but a little higher in bit rate. In addition, it is inferred that the biorthogonal results in a 23 db gain in quality.

7. Conclusions

In this high intensity part there are three kind of image compression techniques that are DCT, Bi orthogonal , singular value decomposition are applied . The analysis of the results at different compression ratios show that results from the bi orthogonal scheme improves with the increase of compression ratio. In future this work can be extended to low intensity part of image also.

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