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Lossy Image Compression Using Singular Value Decomposition and Discrete Wavelet Transform

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ABSTRACT

In this paper a new lossy image compression technique is used with SVD (singular value decomposition) and DWT (Discrete wavelet transform). These techniques are combined in order to the SVD compression to improve the performance of image compression.This compression techniques are reducing redundancy in raw image. Lossy compression is based on the principle of removing subjective redundancy. This paper presents a new lossy image compression technique using SVD and DWT. Generally SVD compression offers very high image quality but the compression ratio was low .In DWT compression technique offers the high compression ratio. In the proposed technique, an input image is first compressed using SVD and then compressed again to increase the compression ratio using with DWT.

Keywords: Discrete Wavelet Transform, Singular Value Decomposition, Compression Ratio, Peak signal to noise ratio, Lossy Image Compression.

1. INTRODUCTION

Image compression is used to reduce the image size like bits. These applications are used in medical field, astronomy, air force, and remote sensing deals with enormous amount of digital images [1]. Image compression technique is used to sharing and storage of large amount of digital images. The amount of data needed to characterize the digital image make transmission slow and storage compressive. This compression technique is deals with reducing the bits size to represent an image by removing Redundancy data. Redundancy take advantage of the fact the human eyes ignore some data, coding Redundancy use codeword to denote the statists of the original data while in to pixel reduction explains the fact that some pixels in an image have some value.

Image compression technique is classifieds into two categories namely lossy and lossless; it depending on the original image can be recovered with scandalized form of compressed image. Lossy and lossless image compression approaches can be applied to hyperspectral image. Lossy compression is based on the principle of removing subjective redundancy [2]. Lossy compression is based on SR original image can be fully recovered in lossy image compression. This technique is useful to build the significant transforms for the lossless image compression. The singular value decomposition (SVD) and Discrete Wavelet Transform (DWT) compression technique is proposed.

SVD is a lossy compression technique which achieves matrix representing an image. The DWT is also compression technique which is based on the Discrete Wavelet algorithm [4]. In our proposed technique the SVD and DWT methods were combined to make a lossy image compression. SVD Compression technique is combined with DWT compression to complement each other. This is because SVD compression technique offers very good PSNR values but low compression ratios. On the other hand, DWT compression technique offers very good PSNR values at very high compression ratios. However, the Performance of the DWT technique can be improved by combining DWT technique with SVD image compression Technique.

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2. RELATED WORK

H.singh et al. [1] presented a hybrid image compression using DWT, DCT & Huffman encoding techniques. Image compression deals with reduce the number of bits needed to indicate an image by removing redundant data. Image compression is extensively categories into two types, namely Lossy and Lossless depending on whether the original image can be recovered with fill mathematic precision from the compressed image. Aharon et al. [2] presented the nonlinear PDE based filters have been extensively implemented in image denoising. However in general, nonlinear filter needs more computing time than most of the linear filters.

I.Daubenchies et al. [3] identified dwt that is used in lossless JPEG2000 compression of grayscale images, reduced to essentials. The high level DWT transforms that provide multi resolution image representation are obtained by mallet decomposition. Advantageous properties of a lifting scheme made it useful to construct significant transforms for the lossless image including discrete wavelet transform. Chen et al. [4] recognized the discrete wavelets transforms adaptively choose the best lifting way and use the Lagrange interpolation Procedure to make predictions according to its local characteristics. Discrete Wavelets Transform, which can adaptively choose the best lifting directions and use the Lagrange interpolation technique to make predictions according to its local uniqueness.

C.H.son et al. [5] JPEG 2000 is a high performance of image compression algorithm .the algorithm have been divided into two groups Lossy Image compression and Lossless Image compression. Lossy compression algorithms aim at high compression Proportion compared with Lossless aim at high compression Proportion. Santa-cruz D. [6] Presented the input image is divided into Non-overlapping N x N blocks. Then each block is transformed using DCT. The DCT confidents of each block are accepted in a wavelet like hierchical manner. Through there exists a number of possible arrangement of coefficients. L.Zhang et al. [7] identified a new frame work for image compressive sensing recovery using adaptively learned scarifying basis via L0 minimization. The intrinsic sparsely of natural images is enforced significantly by sparsely instead of overlapped image patches using the adaptively learned scarifying basis minimum the form of L0 norm, greatly reducing locking artifacts and confining the Cs solution space. z.Gao et al. [8] presented the non-adaptive outcrop representation for the Usual images by conventional CS (CCS) framework may lead to an ineffective compression presentation when comparing to the classical image compression standards such as JPEG and JPEG2000.DCT is used to improving the compressed image quality. G.Bheemeswara Rao et al. [9] identified the Lossy Compression image which does not give good vision of the image, but achieves good compression ratio. After DWT Processing the Bit plane Encoder handles DWT coefficient for statistics compression. The bit Plane encoder encodes a segment of images from most significant bit to least significant bit. Hany Farid et al. [10] Presented Detection of double image compression is important to the analysis of tampered image and image steganalysis. Below the JPEG standard, the DCT Coefficients will have a Phenomenon of interrupted decrease or disappearance duo to recompression the image, which can be used to detect the double JPEG format image.

3. OVERVIEW OF SVD AND DWT

3.1. Singular value decomposition

An image is actually a matrix of numbers whose element is the intensity value of corresponding pixels of the image. Singular valued decomposition is used in order to decompose given matrix into three matrices known as, *U*, Σ, and *V* in which *U* and *V* are orthogonal and Σ is a diagonal matrix containing the sorted singular values of the input matrix in descending order is showing the size of the *U*, Σ, and *V* matrices for given m x n input matrix. The number of non-zero elements on the diagonal of Σ determines the rank of the input matrix. Compression is done by using a smaller rank Σ obtained by eliminating minute singular values (σi) to approximate the original matrix. Mathematically it can be describe as follows:

$$\Sigma_{m\times n} \begin{bmatrix} \overline{\Sigma}_{p\times q} & 0 \\ 0 & \ddots \end{bmatrix} \quad p \le m \text{ and } q \le n$$

As Σ and column with respect to Σ thus some column of *U* and rows of *V* need to be reduced in order to be able to place the matrix multiplications for reconstructing the image.[1]

$$U_{m\times n} = [\overline{U}_{m\times p} \;\; \overline{U}_{m\times(m-p)}] \text{ and } V_{n\times n} = [\overline{V}_{n\times q} \;\; \overline{V}_{n\times(n-q)}]$$

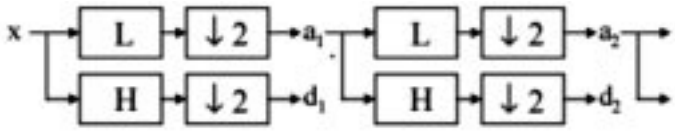
Hence the reconstructed matrix can be obtained by

$$A_{m\times n} = \overline{U}_{m\times p} \;\; \overline{\Sigma}_{p\times q} \; (\overline{V}_{n\times q})^T$$

Because the singular matrix has sorted singular values (in sliding order) by using the physcovisual concept, ignoring low singular value will not significantly decrease the visual quality of the image. The picture being reconstructed by using different amount of particular standards. This characteristic that an image can be reconstructed by fewer amounts of singular values takes SVD suitable for compression .Because after rebuilding of the image the ignored singular values cannot be recovered, the compression by SVD is lossy [1]

3.2. DWT (Discrete Wavelet Transforms)

The discrete wavelet transform (DWT) is a right transformation that operates on a data vector whose length is an integer power of two, converting it into a numerically different vector of the same length. It is a tool that separates data into different occurrence components, and then studies each component with resolution matched to its scale. DWT is computed with a cascade of cleaning followed by a factor 2 sub sampling



H and L denote high and low-pass filters respectively, ↓ 2 represents sub sampling. Outputs of these filters are given by equations (1) and (2)

$$a_{j+1}[p] = \sum_{n=-\infty}^{+\infty} l[n = -2\,p]\, a_j[n]$$

$$d_{j+1}[p] = \sum_{n=-\infty}^{+\infty} h[n - 2\,p]\, a_j[n]$$

Elements a j are used for next step (scale) of the alter and elements d j, called wavelet coefficients, determine output of the convert. l[n] and h[n] are coefficients of low and high-pass filters respectively One can assume that on scale j+1 there is only half from number of a and d elements on scale j. This causes that DWT can be done until only two a j elements remain in the explored signal these elements are called scaling function coefficients. DWT algorithm for two-dimensional images is similar. The DWT is executed firstly for all image rows and then for all column. The main article of DWT is multi scale representation of function. By using the wavelets, given function can be analyzed at various levels of resolution. Dwt is used in lossy image (JPEG 2000) compression of gray scale image. DWT transforms a discrete signal L represent the low-pass filtered signal L (Low frequency) allows the perfect reconstruction of original image. The DWT is also invertible and can be orthogonal. Wavelets seem to be real for analysis of textures recorded with different resolution.

4. FRAME WORK

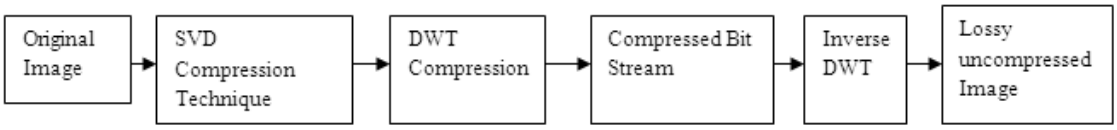


Fig: 1. Block Diagram of SVD- DWT Ccompression technique

In the block diagram the original image is compressed using SVD algorithm then the image is again compressed using DWT technique. After inversing the DWT techniques, the Lossy uncompressed image gets proposed.

5. THE PROPOSED LOSSY IMAGE COMPRESSION TECHNIQUE

The proposed compression technique is processed in SVD based compression is lossy due to the nature of the process. The proposed technique is benefiting from cascading SVD based compression followed by DWT based compression. The SVD technique offers very good PSNR values but low compression ratios and DWT technique offers high compression ratios. The image is first decomposed using SVD, some singular values are ignored and then the image is reconstructed. Then the reconstructed image is used as input image for the DWT part of the proposed technique. The higher number of loops of singular values is ignored at the SVD part of the proposed technique, the higher the compression ratio. Then the overall compression percentage is then calculated as the multiplication of the SVD based compression with that of DWT.

Table I: IMAGE COMPRESSION TECHNIQUE USING SVD-DWT PROPOSED

S.No	*ImageName*	*Image*	*Paper[1]*	*Paper[3]*	*ProposedSVD-DWT*
1	Lena		39.05	17.65	48.21
2	Peppers		39.12	15.74	50.02
3	Boats		33.81	17.39	45.22
4	Baboon		37.77	12.05	43.19
5	Barbara		31.61	19.59	39.17

In the Table1 SVD and DWT Proposed results are plotted in the Table 1. In the proposed technique Lena, Peppers, Boats, Baboon, Barbara Images are used to find the higher compression ratios. In the proposed compression technique are using the combination of SVD-DWT techniques giving the high compression ratios.

6. EXPERIMENTAL RESULTS

In the introduction the lossy image compression was tested on Lena, peppers, boats, Goldhill, Barbara images is showing the assessable comparison between the proposed techniques and DWT by use of PSNR for compression ratio. In order to see the presentation of the proposed image compression technique with different compression ratios are prepared 5, 55 and 280. All the images used are 512×512 with 8- bit grayscale representation. In order to ensure consistency, the same test images used in were used. As the PSNR values the performance of the proposed technique over comes the DWT image compression techniques.

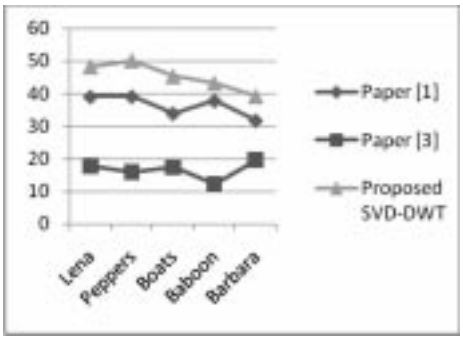


Fig: 2 SVD-DWT Compression Ratio

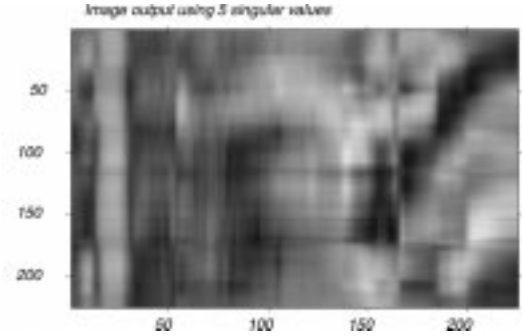


Fig: 3 Image output using 5 singular values

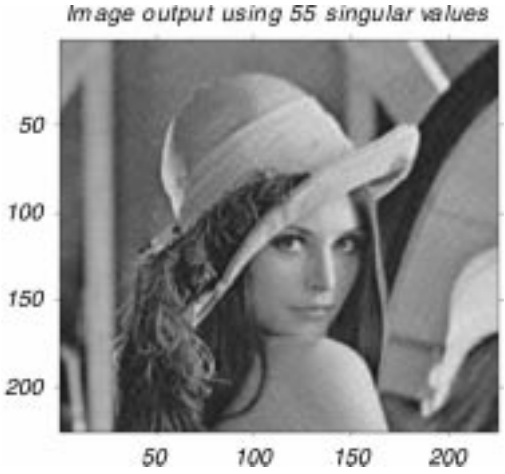


Fig: 4 output using 55 singular values

Fig: 5 output using 280 singular values

Fig: 6 DWT decomposed image

7. CONCLUSION

The lossy image compression technique is proposed by using SVD and DWT. This technique was using SVD in format to neglect the low singular values, and then reconstruct a compressed image. This image was compressed again by using

DWT. The compression ratio was obtained by multiplication of the SVD based compression ratio with the DWT based compression ratio. The results of the proposed technique were also compared with several state-of-the-art image compression method. The quantitative and visual results showed the superiority of the proposed compression method over the state-of-the-art technique.

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