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Lossy Image Compression Using Hybrid SVD-WDR

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Abstract -*In this paper a new image compression technique is presented using Singular value decomposition (SVD) and wavelet difference reduction (WDR). In this we have done hybridization of these two techniques in order to achieve higher compression rate and better image quality. The first technique that is SVD provides high image quality and low compression rate whereas, the other technique that is WDR provides high compression rate but low image quality. The methodology used for the proposed technique is as follows: First image is compressed by using SVD and then again compressed by using WDR technique to acquire better results for compression rate and image quality. The proposed technique is tested on several images and the results are compared with JPEG2000, WDR, SVD in terms of PSNR and MSE. The results obtained by the proposed technique have shown superiority to the several state-of-art techniques.*

***Key Words*:Compression rate, Peak signal to noise ratio (PSNR), Mean square error (MSE), Joint photographic expert group (JPEG2000), Singular value decomposition (SVD), Wavelet Difference Reduction (WDR).**

1.INTRODUCTION

One of the applications of DIP is transmission and encoding. The very first image that was transmitted over the wire was from London to New York through the medium of a submarine cable. The picture that was evacuated took three hours to grasp from one place to another. Now just imagine that today we are able to see live videos, or live CCTV footage from one corner of the world to another and just in a lag of seconds. It means that a lot of research has been done in this field. Image compression does not only focus on transmission or storage but also on encoding. To encode photos many high and low bandwidth formats are developed and then stream it over the internet or etc. Image compression is one of the solutions for these kinds of problems. The purpose of image compression is to reduce irrelevant and redundant pixels of the image in order to be capable to store or transmit data in an efficient form. Image compression minimizes the size in bytes of a graphics file without corrupting the quality of the image to an unacceptable level. The contraction in file size permits more images to be stored in an inured amount of disk or memory space. It also results in the reduction of time to post the images on internet or download the image from the web pages.

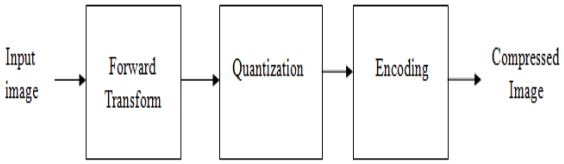

Fig. 1 Basic model of Image compression

The image compression is of two types that is lossy image compression and lossless image compression. Lossless and lossy compressions are terms that specify whether or not, during the compression of a file, the whole original data can be recovered when the file is decompressed. In this we are working on Lossy image compression to make it better. The JPEG2000 is a compression technique that is based upon discrete wavelet transform and 'tiling'. It is the process of partitioning the original image into blocks. Tiling results into less storage space and efficient compression rate. This is a state-of-the-art technique. SVD is another efficient technique that offers very high quality of image but low compression rate. Here SVD is hybrid with WDR which is a wavelet difference based technique and offer high compression rate. This proposed technique is compared with state-of-the-art techniques that are SVD, WDR, and Jpeg 2000. The proposed technique outperforms the above mentioned techniques in terms of PSNR and MSE.

2. OVERVIEW OF SVD AND WDR

2.1 Singular value decomposition

As we know an image is a matrix of numbers whose elements are intensity values of corresponding pixels of an image. SVD is used to decompose a matrix into further three matrices that are U, Σ and V where U and V are orthogonal and Σ is diagonal matrix. By simple applying SVD we can't compress the image. After applying SVD we retain some singular values that are stored at the diagonal matrix in descending order. It is considered that the very first singular value contain the largest amount of information and as we goes in descending the subsequent singular values contain the reducing information. Thus the lower singular values contain minimum or negligible amount of information, so we can ignore these values. More the values we ignore the more will be compression rate.

$$A_{m\times n} = U_{m\times m}\Sigma_{m\times n}(V_{n\times n})^T \quad (1)$$

$A_{m\times n}$ is the image matrix and $(V_{n\times n})^T$ means transpose of V matrix.

$$\Sigma_{m\times n} = \Sigma_{p\times q}\ 0 \quad p<m \text{ and } q<n \quad (2)$$

$$0 \quad ....$$

As Σ has low number of rows and columns as compare to Σ so some column of U and V are need to reduce for the matrix multiplication for reconstructing the image.

$$U_{m\times m} = [U_{m\times p}\ U_{m\times(m-p)}] \text{ and}$$

$$V_{n\times n} = [\ V_{n\times q}V_{n\times(n-q)}\ ] \quad (3)$$

Hence the reconstructed matrix can be obtained by:

$$A_{m\times n} = U_{m\times p}\Sigma_{p\times q}(V_{n\times q})^T \quad (4)$$

2.2 Wave difference reduction

The wavelet difference reduction (WDR) is wavelet base technique which can be lossy or lossless. Here in our proposed work we have used lossy WDR. First the Discrete Wavelet transform (DWT) is applied to the given image followed by bit plane encoding. The bit planer encoding consists of five phase as shown in the Fig. 2. At the very first stage, an initial threshold To is chosen such that the value of To is greater than all the transform values and minimum one transform value has a magnitude of To/2. After the initialization stage, the threshold T=Tk– 1 is updated to T=Tk, where Tk=Tk−1/2. At the significant pass stage, new

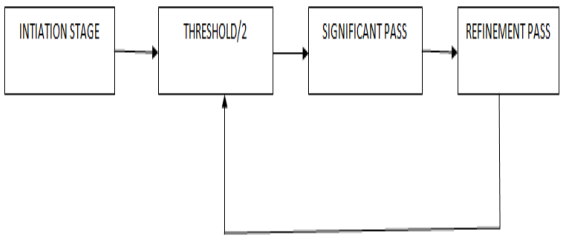

Fig. 2 WDR

which satisfy T<|w(i)| <2T are identified. By using alter reduction method, their index values are encoded [3].

For example consider threshold values as T1=13, with significant values w (2) =36, w(5)=−62, w(9)=32, and w(19)=63. The indices are 2, 5, 8, and 19but instead of working with indices WDR will work with their difference such as 3, 4, and 10. The first number is considered as the index and the successive are considered as the number of steps to be followed to reach to the next index. In refinement pass the errors are refined by quantization. In order to reconstruct the image all steps are revised by using inverse wavelet transform (IWT).

3. PROPOSED WORK

As we have mentioned earlier the proposed technique is hybridization of the SVD and WDR technique. The image is first decomposed using eq. 1 and then some singular values are ignored to compress it. Higher the number of values of ignored higher will be the compression rate. After compressing it the image is decompressed by using eq. 4. Then the decompressed image is again compressed by using WDR. At the side of WDR technique the maximum no of loops are fixed at 12. Then the final compression rate is calculated by multiplying the compression rate obtained by SVD and compression rate obtained by the WDR. The

Block Diagram Of The Proposed Technique Is As Shown In Fig 3.

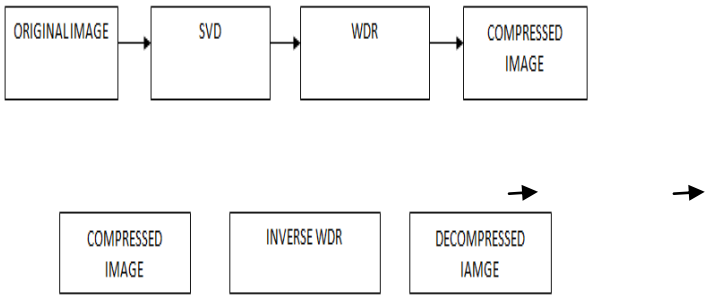

Fig. 3 Methodology of proposed work

In next section we are going to discuss the experimental results and will compare the results with several state-of-the-art techniques.

4. EXPERIMENTAL RESULTS AND DISCUSSION

Table 1 Comparison table at 20:1

Parameters	Image/method	SVD	WDR	JPEG20000	Proposed
PSNR	0.tif	22.33	22.71	22.64	25.50
SSIM		0.477	0.470	0.520	0.752
PSNR	1.tif	22.80	23.82	25.69	26.69
SSIM		0.680	0.620	0.767	0.910
PSNR	2.tif	22.80	22.73	24.33	24.84
SSIM		0.561	0.521	0.596	0.832
PSNR	3.tif	26.89	26.96	26.76	27.57
SSIM		0.699	0.710	0.740	0.809
PSNR	4.tif	22.91	22.03	23.03	27.21
SSIM		0.651	0.641	0.692	0.854
PSNR	5.tif	29.99	30.75	31.96	30.44
SSIM		0.916	0.900	0.912	0.880
PSNR	6.tif	27.29	27.07	27.30	33.03
SSIM		0.786	0.764	0.606	0.898
PSNR	7.tif	22.80	27.72	27.69	33.37
SSIM		0.561	0.625	0.670	0.899
PSNR	8.tif	26.89	29.71	29.62	31.24
SSIM		0.699	0.777	0.808	0.883
PSNR	9.tif	22.91	28.93	29.54	31.90
SSIM		0.651	0.743	0.783	0.907
Average PSNR	Total Images	21.71	27.71	26.12	41.17
SSIM	(10)	0.633	0.689	0.711	0.745

As it was told earlier the proposed technique is tested on various images. Table 1 is showing the quantitative as well as qualitative comparison between the proposed technique and SVD, JPEG2000 and WDR by use of PSNR for compression ratio of 20:1. To see the performance of the proposed hybrid SVD-WDR technique with different compression ratios Tables 1 and 2 are with compression ratio of 20:1 and 80:1 respectively are prepared.

Table 1: Comparison table at 80:1

Parameters	Image/method	SVD	WDR	JPEG20000	Proposed
PSNR	0.tif	22.33	22.71	22.64	25.50
SSIM		0.477	0.470	0.520	0.752
PSNR	1.tif	22.80	23.82	25.69	26.69
SSIM		0.680	0.620	0.767	0.910
PSNR	2.tif	22.80	22.73	24.33	24.84
SSIM		0.561	0.521	0.596	0.832
PSNR	3.tif	26.89	26.96	26.76	27.57
SSIM		0.699	0.710	0.740	0.809
PSNR	4.tif	22.91	22.03	23.03	27.21
SSIM		0.651	0.641	0.692	0.854
PSNR	5.tif	29.99	30.75	31.96	30.44
SSIM		0.916	0.900	0.912	0.880
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PSNR	7.tif	22.80	27.72	27.69	33.37
SSIM		0.561	0.625	0.670	0.899
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SSIM		0.651	0.743	0.783	0.907
Average PSNR	Total Images	21.71	27.71	26.12	41.17
SSIM	(10)	0.633	0.689	0.711	0.745

All the images used are 512 × 512 with 8-bit gray-scale representation. PSNR values of the JPEG2000 compression were obtained from [3]. In order to ensure consistency, the same test images used in [3] were used. As the PSNR values show in Tables 1 and 2 the performance of the proposed technique overcomes the JPEG2000, SVD and WDR image compression techniques. The reason for the high gain in PSNR values is because of the SVD compression as it serves as a 'booster' and it compresses the image without ample loss in quality and that is the reason overall compression is improved when WDR is applied WDR compression is applied. The SSIM values show that the proposed technique outperforms WDR, SVD and JPEG2000 techniques.

The graph is showing the superiority of the proposed technique over the other state-of-the-art techniques. In

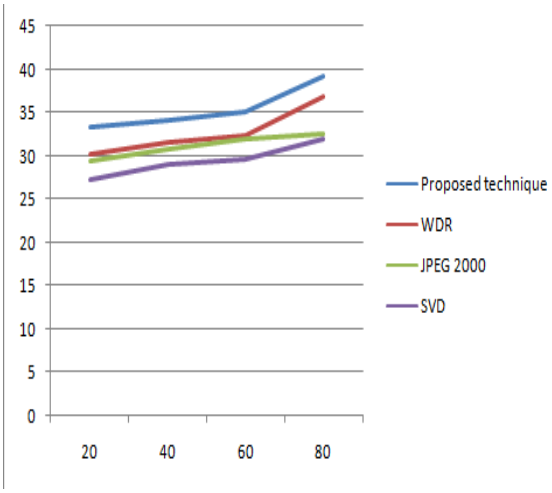

Fig. 3 Graphical analysis

general, the quantitative and qualitative results show that the proposed hybrid SVD-WDR is an outstanding technique with high performance even at high compression ratios (80:1).

5. CONCLUSION

In this paper, we have proposed a new technique by combining two existing techniques that is SVD and WDR. This hybrid SVD-WDR technique leads to better compression rate and image quality. We have compared the results of hybrid SVD-WDR technique with SVD, WDR and JPEG2000 and the results are showing superiority over these techniques.

6. FUTURE SCOPE

There is an advance version of wavelet difference reduction that is adaptive scanned wavelet difference reduction (ASWDR). As ASWDR give more compression rate than the WDR, so on future we can hybrid SVD with ASWDR instead of WDR.

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