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# A NEW HYBRID APPROACH TO DICOM MEDICAL IMAGE COMPRESSION

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## ABSTRACT

*This paper focuses on the very important aspect of image compression and that too on the medical images which are very important so far as diagnosis of various dieses are concerned. This paper focuses on two major aspects i.e. compression on medical images so that the storage space and bandwidth can be saved and also keeping very important information for effective diagnosis. In this paper we have made use of hybridization of Singular Value Decomposition (SVD) and Discrete wavelet transform (DWT) for the lossy image compression followed by arithmetic coding for the lossless image compression. We utilized Peak Signal to Noise Ratio(PSNR), Mean Square Error (MSE), Compression Ration, Correlation and Elapsed Time for the sake of performance measurement and comparison.*

***Keywords: Compression Ratio, DWT , Image Compression, SVD, Visual Quality Matrices***

## I. INTRODUCTION

The amount of data produced by medical imaging techniques is vast and this might be a problem for storing and sending the data over a network. To overcome this problem, image compression has been introduced in the field of medical. There are several types of image compressions available but in case of biomedical images the loss of diagonasability of the image is not tolerable and hence to achieve higher degree of compression without any significant loss in the diagonasability of the image. JPEG was developed in 1992, using the DCT is simple and it is the widely used technique for compression, but results in blocking artifacts, ringing effects and false contouring appreciably for high compression ratio [10][12]. Wavelet transform provides numerous desirable properties such as multi-resolution representation; scalability and progressive transmission which are beneficial to image compression applications as there is a need to handle lots of medical images in the hospitals. Discrete Wavelet Transform (DWT) based coding, is another efficient technique used for image compression. The ability to display image at different resolutions like low frequencies and high frequencies simultaneously makes it a better method compared to others [11]. To achieve higher degree of compression we have to choose the hybrid scheme of DWT, DCT and Huffman encoding compression technique. This paper proposes an approach to improve the performance of medical image compression while satisfying medical team who need to use it.

In this paper, an efficient hybrid SVD - DWT technique for image compression is presented. In the preceding section some idea is given about the technical functionality of DWT followed by the same in next section.

Section 4 describes the proposed method. Section 5 gives the results and comparison. At the end the conclusion is given followed by references.

## II. DISCRETE WAVELET TRANSFORM

The Basic Idea of the Discrete Wavelet Transform [16 - 25] may be understood by taking a one dimensional signal which is first split into two parts, usually high frequencies and low frequencies [16]. The low frequency part is split again into two parts of high and low frequency. This process is continued until the signal has been entirely decomposed. Furthermore, from the DWT coefficients, the original signal can be reconstructed. The reconstruction process is called the inverse DWT (IDWT).The idea of the DWT is as shown in the figure 1.

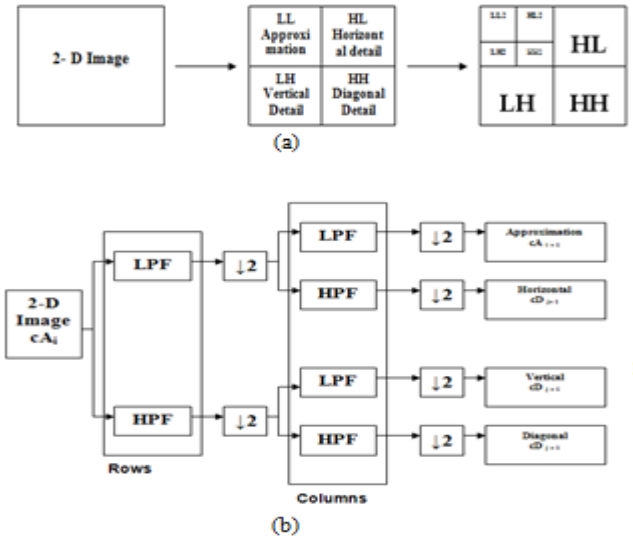



**Fig 1. Basic Decomposition Steps For Images**

## III. SINGULAR VALUE DECOMPOSITION

Singular value decomposition (SVD) [26, 27] is a numerical technique based on the linear algebra and it is used to diagonalize matrices in numerical analysis. It is an algorithm developed for a variety of applications.

When we apply SVD to an Image A of size MxN, we find three matrices, namely U, V and S whose properties are:

- We can represent $A = USV^T$.
- U and V matrices are called unitary matrices having size MxM and NxN respectively.
- S matrix is called diagonal matrix having size MxN.
- The columns of the U matrix are called the left singular vectors while the columns of the V matrix are called the right singular vectors of A.
- The diagonal entries of S are called the singular values of A and are arranged in decreasing order
- The singular values (SVs) of an image have very good stability, i.e., when a small perturbation is added to an image, its SVs do not change significantly;
- SVD is able to efficiently represent the intrinsic algebraic properties of an image, where singular values

correspond to the brightness of the image and singular vectors reflect geometry characteristics of the image.

- An image matrix has many small singular values compared with the first singular value. Even ignoring these small singular values in the reconstruction of the image does not affect the quality of the reconstructed image.

## IV. PROPOSED METHOD

Here we have proposed an algorithm which makes use of hybridization of the SVD and DWT which are responsible for the lossy compression followed by arithmetic coding of the result which again compresses the image but in a lossless manner.

Following is the pseudo code for the proposed algorithm.

1. Ask from the user about the image to be compressed
2. Check whether the image is color or grayscale
3. If image = color
   a. Convert the image from RGB plane to YCbCr plane
   b. Select Y component for further processing

   Else if image = grayscale
   c. Select image for further processing

   End
4. SVD is applied on selected grayscale image or Y component of the color image.
5. Some N columns are kept and other are deleted in Unitary matrices for compression (Lossy)
6. Whereas N rows and N columns are kept in Singular component.
7. As the value of N increases the quality of the image increases and the compression ratio decreases
8. Processed image is given to Discrete Wavelet Transform
9. Approximation component is selected for further process with all other parts quantized with the quantization table.
10. Arithmetic coding is applied on the every component of the image for compression (Lossless)

## V. VISUAL QUALITY PARAMETERS

We have mainly used the following visual quality matrices [13] for the sake of comparison of degradation after the compression.

$$MSE = \frac{1}{M \times N}\sum_{x=1}^{M}\sum_{y=1}^{N}\{(f(x,y) - f'(x,y))\text{^}2\} \qquad (1)$$

$$PSNR = 10 \times \log\frac{255^2}{MSE} \qquad (2)$$

Here MSE – Mean Square Error

PSNR – Peak Signal to noise Ratio

f(x,y) – Original Frame

f'(x,y) – Compressed Frame.

The phrase peak signal-to-noise ratio [14], often abbreviated PSNR, is used to measure the similarity between

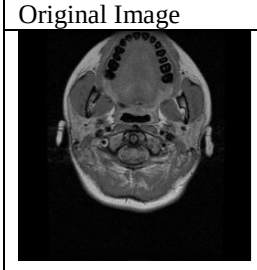
two signals where in one is original and the other is altered version of the same. PSNR can be defined via the Mean Square Error (MSE) which gives us the idea of difference between the original and the altered signal. PSNR is measured in the logarithmic scale and MSE is measured in the general scale.

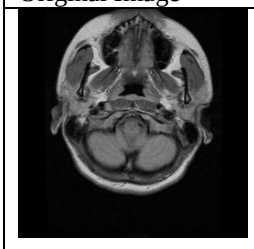
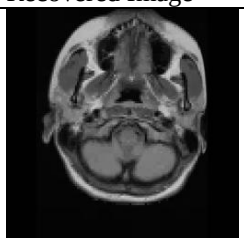
At the receiver end we recovered the image and measured the quality with the help of the correlation function.

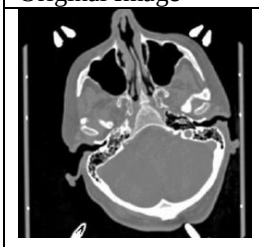
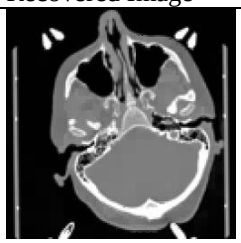
## VI. RESULTS

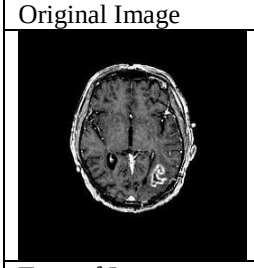
Following Table shows the results that we got from the proposed algorithm which gives significant improvement over traditional JPEG algorithm. In result section we utilized the all kind of medical images that are DICOM images, CT images, MRI images and PET images and we achieved the outputs as shown in the table.

**Table 1:- Results of the Proposed Algorithm**

| Original Image | Recovered Image |
|---|---|
|  |  |
| Type of Image | Dicom |
| Original Image Bits | 524288 |
| Bits to be Transmitted | 141664 |
| Compression | 72.979736 |
| PSNR | 31.7877 |
| MSE | 43.0832 |
| Correlation | 0.6308 |
| Elapsed Time | 6.5832 |

| Original Image | Recovered Image |
|---|---|
|  |  |
| Type of Image | Dicom |
| Original Image Bits | 524288 |
| Bits to be Transmitted | 160948 |
| Compression | 69.301605 |
| PSNR | 31.4798 |
| MSE | 46.2488 |
| Correlation | 0.6413 |
| Elapsed Time | 7.1916 |

| Original Image | Recovered Image |
|---|---|
|  |  |
| Type of Image | CT |
| Original Image Bits | 524288 |
| Bits to be Transmitted | 160948 |
| Compression | 69.301605 |
| PSNR | 31.4798 |
| MSE | 46.2488 |
| Correlation | 0.6413 |
| Elapsed Time | 7.1916 |

| Original Image | Recovered Image |
|---|---|
|  |  |
| Type of Image | MRI |
| Original Image Bits | 524288 |
| Bits to be Transmitted | 124322 |
| Compression | 76.287460 |
| PSNR | 35.0818 |
| MSE | 20.1792 |
| Correlation | 0.9386 |
| Elapsed Time | 6.2326 |

Following table 2 shows the comparison between the proposed algorithms with the famous algorithms.

**Table 2:- Comparative Analysis**

| **Parameter** | **PSNR** | **Compression Ratio** |
|---|---|---|
| RLE | 47.78 | 2.5 |
| JPEG | 26.12 | 51.12 |
| Wavelet | 24.25 | 50 |
| **Proposed** | **31.78** | **72.97** |

## VII. CONCLUSION

It is observed from the results that both PSNR and Compression ratio achieved is higher than the popular method like JPEG, RLE etc. At the same time MSE and Elapsed time is very much small comparatively. So this method is able to achieve the high quality and less space requirement.

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