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# ANALYSIS OF COLOR IMAGE COMPRESSION USING WAVELET TRANSFORM

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## ABSTRACT
Images have considerably higher data storage requirement than text .This paper gives compression of color image by using Haar Wavelet Transform and 3D wavelet transform techniques for various size with respect to the parameters such as compression ratio, mean square error and peak signal to noise ratio respectively and observe that these parameters shows better performance and superior image quality in Haar wavelet than 3D wavelet.

**KEYWORDS**: Haar Wavelet Transform, 3D wavelet, MSE, PSNR.

## I. INTRODUCTION
Images have considerably higher data storage requirement than text; Audio and Video data require more demanding properties for data storage. An image stored in an uncompressed file format, such as the popular .BMP format, can be huge. An image with a pixel resolution of 640 * 480 pixels and 24-bit color resolution will take up 921,600 bytes in an uncompressed format [1].

## II. WAVELET TRANSFORM
A Wavelet transformation converts data from the spatial into the frequency domain and then stores each component with a corresponding matching resolution scale. The word "wavelet'' stands for an orthogonal basis of a certain vector space [2]. In order to evaluate the performance of the image compression coding techniques, it is necessary to define a measurement that can estimate the difference between the original image and the decoded image. Such parameters are Compression ratio, Bits per pixels, MSE and PSNR.

The compression ratio is defined as follows:

$$\text{Compression ratio} = \frac{\text{Original Image size}}{\text{Compressed image size}}$$

$$\boldsymbol{CR} = \frac{\mathbf{n1}}{\mathbf{n2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where n1 is the size of original image and n2 is that size of compressed image. For better compression CR must be a Higher but it degrades the quality of image.

$$\text{MSE} = \sqrt{\frac{\sum_{x=0}^{W-1} \sum_{y=0}^{H-1} [f(x,y) - f'(x,y)]2}{WH}} \quad \ldots \ (2)$$

$$\text{PSNR}=20\log10\frac{255^2}{MSE} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

For better compression performance the MSE should be minimum and PSNR should be higher

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## III. METHODOLOGY

### 1. Haar Wavelet Transform

The Haar Transform (HT) is one of the simplest, memory efficient, exactly reversible without the edge effects technique. It is fast and basic transformations from the space domain to a local frequency domain. A HT decomposes each signal into two components, one is called average (approximation) or trend and the other is known as difference (detail) or fluctuation. The original resolution of the images is converted into the next larger power of two, and the array sizes are initialized consequently. The Haar transform separates the image into high & Low frequency components.[4] For the first cycle, the transformation algorithm is first run along the ROW as shown in figure 1.

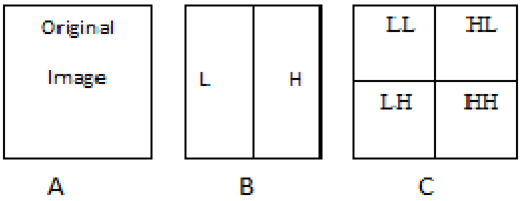


***Figure.1. Wavelet Transform***

Where,
A – Original Image
B – First Run along Row
C – First Run Along Column
The image array sizes are expressed in powers of two. Mathematically, after transforming the image in the row, the image is then transformed along the column.as shown in fig 1.c.
This can be explained with a simple 1D image with eight pixels

[3 2 -1 -2 3 0 4 1]

So the image after one Haar Wavelet Transform is:

Transformed coefficient = [2.5 -1.5 1.5 2.5]
Detail Coefficients = [0.5 0.5 1.5 1.5]

The detail coefficients used in image reconstruction. [5]. In 2D wavelet transformation, structures are defined in 2-D and the transformation algorithm is applied for row first, and then for column. the values of first average sub signal a1=(a1, a2,........,aN/2), at one level for a signal of length N i.e. $f=(f_1, f_2, f_3, .........,f_N)$ is

$$a_n = \frac{f2n-1 + f2n}{\sqrt{2}}, \ n=1,2,3,.....,N/2, \qquad (4)$$

and first detail subsignal, at the same level $d^1 =(d_1,d_2,........,d_{N/2})$, is given as

$$d_n = \frac{f2n-1 - f2n}{\sqrt{2}}, \ n=1,2,3,.....,N/2, \qquad (5)$$

By applying 2D HT to the finite 2D signal. The corresponding signal are transformed with Approximation and detailed signal. Using 1D HT along first row, the approximation coefficient

and the detail coefficient are determined resp. With the same transformation is applied to the other row of Image signal. Similarly by arranging the approximation parts of each row transform in the first column and detail parts in last two columns[5][6]

In which approximation and detail parts are separated by dot in each row. By applying the step of 1D HT to the column to the resultant matrix we find the resultant matrix at first level is, each piece has a dimension (number of rows/2)×(number of columns /2) and is called A, H, V and D respectively. Where A (approximation area) includes information about the global properties of analyzed image. H (horizontal area) includes information about the vertical lines hidden in image. Removal of spectral coefficients from this area excludes horizontal details from original image. V (vertical area) includes information about the horizontal lines secreted in image. Deduction of spectral coefficients from this area eliminates vertical details from original image. D (diagonal

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area) accept information about the diagonal details hidden in image. Removal of spectral coefficients from this area leads to minimum distortions in original image.[11]

**2. 3D Wavelet Transform**

The 3 D wavelet image compression method transformation uses the ability to information of the 3D representation to exploit the interpixel relations. In this orthographic projection is used for converting the 3D mesh into a 2D image. The proposed conversion method does not change the connectivity among the vertices of the 3D model [10].There is a correlation between the pixels of the composed image due to the connectivity of the 3D mesh. Known image compression tools cannot take advantage of the correlations between the samples. The wavelet transformed data is then encoded using a ZWT based method[10].. Since the encoder creates a hierarchical bit stream, the proposed technique is a progressive mesh compression technique. Experimental results show that the proposed method has moderate performance relating to proposed parameters [7]

This method uses the integral imaging technique capable of displaying 3D images with continuous parallax in full natural color and which is capable of creating and encoding a true volume spatial optical representation of the object view in the form of a planar intensity distribution by using unique optical components. The huge quantity of bits requisite to represent the captured 3D integral image with sufficient resolution, it is necessary to develop compression algorithms tailor to take advantage of the characteristics of the recorded 3D integral image. The planar intensity distribution representing 3D integral image is comprised of 2D array of micro-images [8]

In the last few years, a lossy compression scheme for use with 3D integral images, making use of a three-dimensional discrete cosine transform (3D-DCT) has been developed .It was shown that the performance with respect to compression ratio and image quality is vastly improved compared with that achieved using baseline JPEG for compression of 3D integral image data. Karhunen-Loeve transform (KLT) has also been used to compress integral images [10].

## IV. RESULTS

The algorithm of proposed compression methods are tested with different color images such as Lena Image and Satellites image. For the analysis of wavelet transform techniques for compression of color image we use various types of color images as input to wavelet which are of size 64 X 64, 128 X 128, 256 X 256, pixels. This selected image is compressed and decompressed by each of wavelet transform methods separately. are compared with different parameters like Compression ratio(CR), Bits per pixels(BPP), Mean Square Error(MSE), Peak Signal to Noise Ratio(PSNR). We observe the following results and is summarized in the table I, and table II resp.

**a) Compression using Haar wavelet Transform**

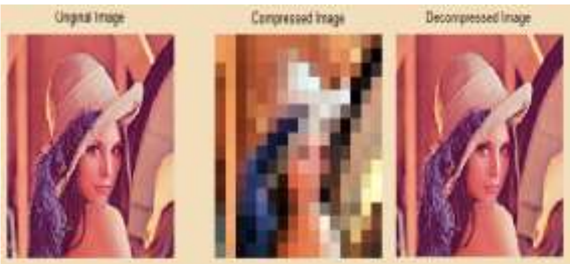


***figure 1.Lena Image of size 128 X 128 pixel***

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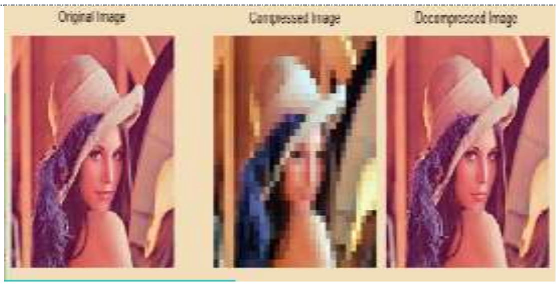


*Figure 2 Lena Image of size 256 X 256 pixel*

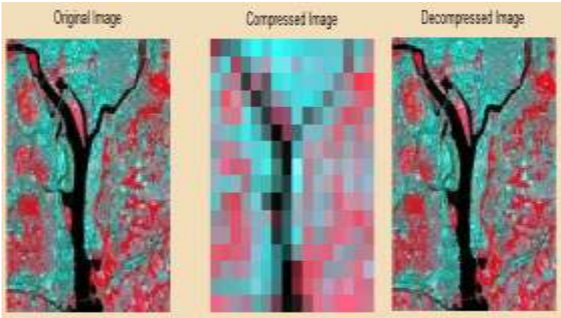


*Figure 3. Satellite Image of Size 128 X 128 pixel*

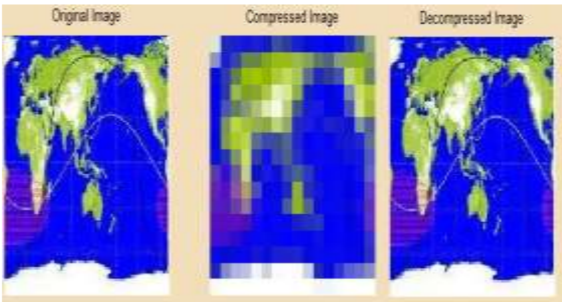


*Figure 4. Satellite Image of Size 128 X 128 pixel*

**b) Compression using 3D wavelet Transform**

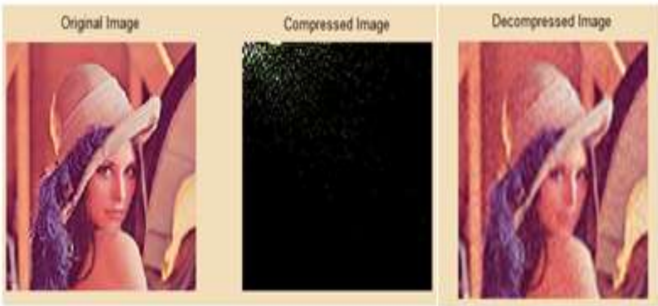


*Figure 5. Lena Image of Size 128 X 128*

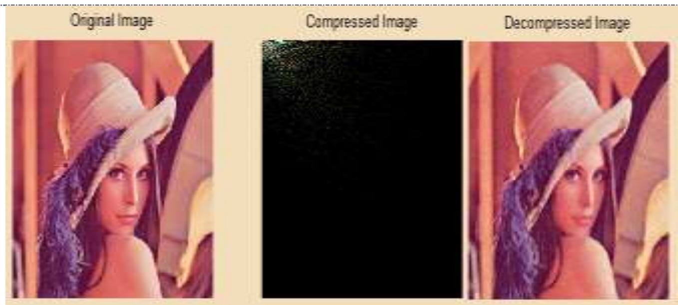


***Figure. 6 Lena Image of Size 256 X 256***

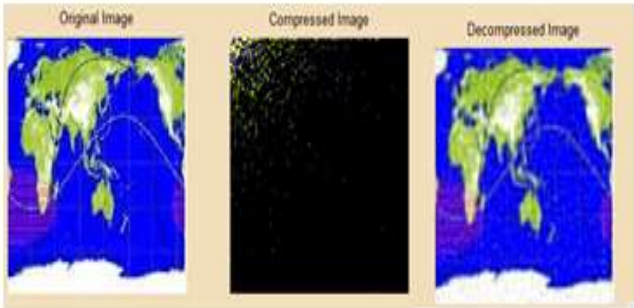


***Figure 7 Satellite Image of size 128 x 128***

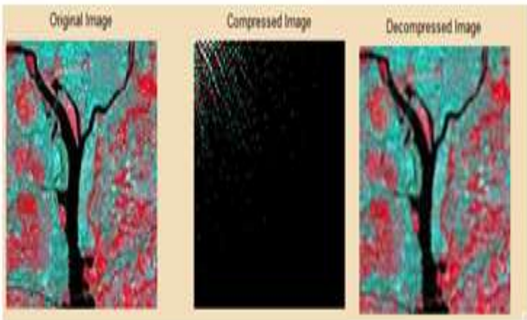


***Figure 8 Satellite Image of size 128 x 128***

## V. COMPARATIVE ANALYSIS

In this study, we compare different wavelet transform techniques of color image compression. The prominent intensity methods studied in this study include segmentation A critical comparison of the studied methods is summarized in the comparison (Table I, II)

***Table I. Performance of Different Wavelet Methods Lena Image***

| Sr. No | Wavelet Method | Type | Size (Pixel) | Parameters | |
|---|---|---|---|---|---|
| | | | | MSE | PSNR |
| 1 | Haar | Lena | 64 X 64 | 0.000022 | 94.7944 |
| | 3D Wavelet | | | 0.002028 | 75.0611 |
| 2 | Haar | | 128 X 128 | 0.000012 | 97.2159 |
| | 3D Wavelet | | | 0.000979 | 78.2247 |
| 3 | Haar | | 256 X 256 | 0.000009 | 98.6167 |
| | 3D Wavelet | | | 0.000429 | 81.8067 |

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***Table II. Performance of Different Wavelet Methods for Satellite Image***

| Sr.No. | Wavelet Method | Type | Size (Pixel) | Parameters | |
|---|---|---|---|---|---|
| | | | | MSE | PSNR |
| 1 | Haar | SAT 1 | 128 X128 | 0.000065 | 90.002 |
| | 3D Wavelet | | | 0.001265 | 77.1091 |
| 2 | Haar | SAT 2 | 128 X 128 | 0.000017 | 95.9286 |
| | 3D Wavelet | | | 0.001773 | 75.6434 |

## VI. CONCLUSION

In this work we have provided the wavelets transform and 3D Wavelet Transform used in color image compression system and results are compared for the processing of different images with the defined parameters as MSE, PSNR etc. The main benefit of HWT is representation of fast algorithms and simple calculations. From test images we find that the Haar wavelet transform for image compression is simple and obsolete algorithm, as compared to other algorithms it is more effective. The quality of compressed image is also maintained. The most probable results with Haar wavelet transform algorithm can be obtained. In future it can also be checked with different application images such as Medical Image, Agricultural image, satellite image, military application etc..

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