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Analysis and Implementation of Lossless Image Compression for Various Formatting Images

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Abstract: **- Digital image compression is a method of image data reduction to save storage space. Image compression is the process of reducing the size of the image that will enhance images sharing, image transmission and easy storage of the image. There are two types of image compression techniques. In Lossy compression, the compressed image is not equal to the original image; it means the quality of compressed image is less than the original image. In Lossless compression the compressed image is exactly equal to the original image. In this work, the analysis of different format of images have been implemented using the Lossless image compression techniques such as Huffman coding, EZW and SPIHT. Huffman encoding technique basically works on the rule of probability distribution. The principle is to reduce the size of the image by removing redundancies. Less number of bits is used to encode the image. Huffman encoding method is used in JPEG image. Set partitioning in hierarchical trees (SPIHT) is a wavelet-based image compression technique. It gives good image compression ratios and image quality. EZW method is based on progressive encoding to compress an image. Experimental result was carried out on four types of image format such as .bmp, .jpg, .png, .tif. The Performance metrics such as Peak signal-to-noise ratio (PSNR), Compression Ratio (CR), Mean square error (MSE), Bits per pixel (BPP) were measured for each format of images.**

Keywords: **Image Compression Techniques, Huffman coding, SPHIT, EZW, PSNR, MSE, BPP..**

I. INTRODUCTION

Image compression can be defined as minimize the total in bytes of a graphics file not including degrading the quality of the image to an unacceptable level. The reduction allows more images to be stored in a given amount of memory space but the major benefit is the reduction of the time required for image transmission. There are several different formats like JPEG, TIF, BMP, and PNG in which image files can be compressed using image compression techniques. They are categorized into lossless and lossy compression.

A. Huffman Coding

Huffman encoding method for the lossless compression of files based on the frequency of occurrence of a symbol in the file that is being compressed. The Huffman method is based on numerical coding which means the probability of a symbol has a direct bearing on the length of its representation. The principle is to reduce size of the image by removing redundancies. Less number of bits is used to encode the image. In first step frequency of each symbol is calculated and then code is assigned to it. Symbol with more probability gets short code. Codes are stored in a code book which may construct for each image. For image decompression both code book and encoded data transmitted to extract original image. For implementation of Huffman Encoding method in MATLAB Huffman encode ( ) and Huffman decode ( ) in build functions are available. Huffman encoding method is used to compress JPEG images [1]

B. Embedded Zero Tree Wavelet (EZW)

The embedded zero tree wavelet method (EZW) is a valuable image compression algorithm. The EZW method is based on four main concepts: 1.Discrete wavelet transform or hierarchical sub-band decomposition, 2. Prediction of the absence of significant information across scales entropy coded 3.successive-approximation quantization and 4.Universal lossless data compression which is accomplished via adaptive arithmetic coding.EZW coding method is most significant progressive methods for image compression techniques. In this method, combine stepwise thresholding and progressive quantization [2].

C. Set Partitioning in Hierarchical Trees (SPIHT)

SPIHT is one of the wavelet based image compression method .This method yields good visual quality. SPIHT exploit the property of the wavelet-transformed images to increase its efficiency. The SPIHT (Set Partitioning in Hierarchical Trees) method is a quick and efficient technique for image compression and encryption. SPIHT generally operates on an entire image at once. The whole image is loaded and transformed and then the method is requires repeated access to all coefficient values. The

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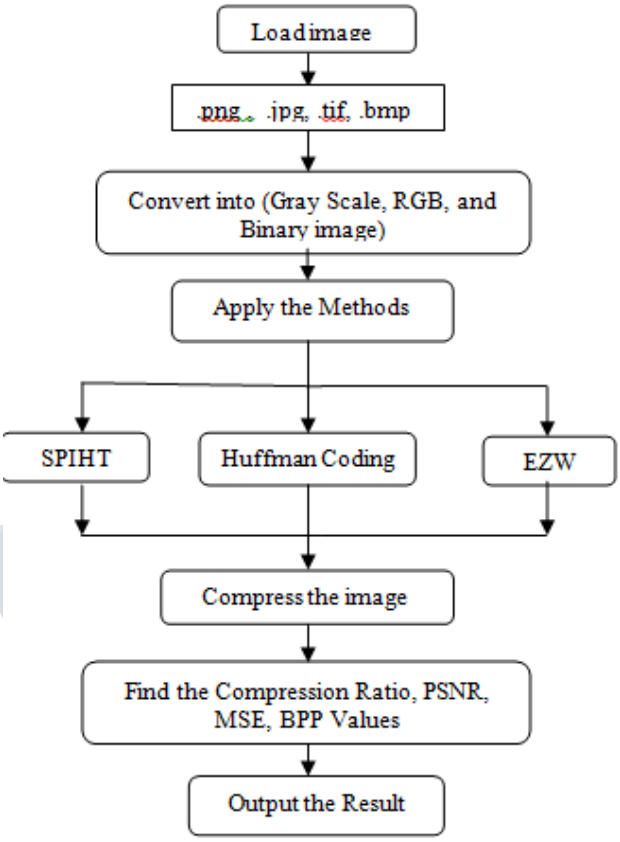
principle of the SPIHT method is partial ordering of the change coefficients by magnitude, with asset partitioning sorting algorithm ordered by bit plane transmission and exploitation of self-similarity across different layer [3].

II. LITERATURE REVIEW

[4] Mridul Kumar Mathur, Seema Loonker, Dr. Dheeraj Saxena, a lossless image compression based on Huffman algorithm is presented. The image is converted into an array using Delphi image control tool. Huffman coding method is used to removes redundant codes from the image and compresses a BMP image file. [5] Jagadeesh B, Ankitha Rao, proposed an approach for Image Compression Using Adaptive Huffman Coding. In this paper, describes the various lossless compression techniques. It provides better compression ratios compared with other lossless coding methods like LZW coding method, JPEG lossless compression. [6] Puja Bharti, Dr. Savita Gupta and Ms. Rajkumari Bhatia proposed a framework for ROI based compression of medical images using JPEG2000 and SPIHT compression techniques.JPEG2000 and SPIHT are the wavelet-based image compression technique. The performance is evaluated using image quality metrics like PSNR, SSIM and Correlation. Wavelet-based coding provides good quality of image and high compression ratio. [7] Bhagyashree I. Kochi and B.B.S.Kumar proposed the analysis of EZW, SPIHT and denoising algorithms. X-ray image has been used for implementing EZW, SPIHT and denoising algorithm. The quality of image is measured by PSNR, MSE and CR. Denoising is calculated by adding Speckle noise for both soft and hard threshold. PSNR value of hard thresholding is 47.53 MSE value of hard thresholding is 1.14. [8] Shwetha M, Ashwini.P , Sujatha B M proposed the six popular image compression algorithms such as DCT, DWT, JPEG,EZW,SPIHT, EBCOT is presented and it is found that SPIHT wavelet based image compression is more efficient due to high compression ratio and simple coding procedure.[9] K.Mahendra Babu 1, Dr. P. Sathyanarayana proposed This paper entails the study of various image compression techniques and algorithms for natural and compound images. Compound images are defined as images that contain a combination of text, natural images and graphic images.

III. METHODOLOGY



IV. PERFORMANCE METRICS

The performance metrics was evaluated using quality metrics such as Compression Ratio (CR), and Peak Signal to Noise Ratio (PSNR), Bits per pixel (BPP), Mean Square Error.

A. Compression Ratio (CR):

CR= (Original image File size)/ (compressed Image File size)

Original size=width*height*number of color planes* bit-depth/8(bytes)

Compressed size=size_in_bytes

As the compression ratio increases, reconstructed image is more compressed and the quality of image will be degrades.

B. Peak Signal to Noise Ratio (PSNR):

Peak Signal to Noise Ratio represents a measure of the peak error and is expressed in terms of decibels The PSNR (in dB) is defined as:

$$\mathbf{PSNR=20.log_{10}\,(MAX_I)-10.log_{10}\,(MSE)}$$

C. Mean Square Error (MSE):

Mean Square Error represents the mean squared error between the compressed and the original image

$$\mathbf{MSE=\Sigma_{m,n}\,[I_{1(m,n)}-I_{2(m,n)}]\;2/\;(M+N)}$$

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D. Bits per Pixel (BPP):
The Bit-Per-Pixel ratio BPP, which gives the number of bits required to store one pixel of the image.

V.EXPERIMENTAL ANALYSIS AND RESULTS

The outcome of experiment using Huffman Coding, EZW and SPIHT image compression techniques are based on MATLAB software. This process is used to find the Peak signal-to- noise ratio (PSNR), Compression Ratio (CR), Mean square error (MSE), Bits per pixel (BPP). Experiments are performed on different image formats extensions such as .png, .tif, .jpg, bmp. Table 1 shows the compression ratio obtained after the processing of the compression methods based on the image formats such as .png, .tif, .jpg, .bmp.

Table 1. Compression Ratio of image compression methods

Image Compression Methods	Compression Ratio			
	.png	.tif	.jpg	.bmp
Huffman Coding	2.32	8.30	2.26	2.90
SPIHT Coding	5.63	11.29	7.00	9.92
EZW Coding	15.74	28.50	18.84	27.17

Table 2 Shows the experimental result based on the bits per pixel value processed on the basis of compression methods using 4 different image formats.

Table 2. Bit per Pixel of image compression methods

Image Compression Methods	Bit Per Pixel			
	.png	.tif	.jpg	.bmp
Huffman Coding	0.56	0.66	0.54	0.70
SPIHT Coding	1.35	0.90	1.68	2.38
EZW Coding	3.78	2.28	4.52	6.52

Table 3 Shows the experimental result based on the peak signal to noise ratio that are obtained by the three compression methods using 4 different image formats.

Table 3. Peak signal to Noise Ratio of image compression methods

Image Compression Methods	Peak Signal to Noise Ratio			
	.png	.tif	.jpg	.bmp
Huffman Coding	29.20	29.74	43.73	82.40
SPIHT coding	35.50	33.10	34.70	33.00
EZW coding	40.44	38.51	39.83	38.95

Table 4 shows the experimental results based on mean square Error that are obtained by the three compression methods using 4 different image formats.

Table 4. Mean Square Error of image compression methods

Image Compression Methods	Mean Square Error			
	.png	.tif	.jpg	.bmp
Huffman Coding	78.00	68.95	26.55	25.51
SPIHT coding	18.00	31.40	21.60	32.00
EZW coding	5.86	9.14	6.74	8.27

VI.COMPARATIVE ANALYSIS

On the basis of experimental results performed a comparative analysis of all the three types of lossless image compression techniques. The process was based on the four types of different image formats such as .bmp, .jpg, .png, .tiff. The Performance metrics such as Peak signal-to- noise ratio (PSNR), Compression Ratio (CR), Mean square error (MSE), Bits per pixel (BPP) were measured for each format of images. From this analysis Huffman coding gives better compression ratio for .JPG images and SPIHT method gives better Peak signal-to-noise ratio for .PNG images and Huffman coding gives better Bit Per Pixel for the .PNG image.
Figure1. Shows the comparative analysis based on the compression ratio. Figure2. Shows the comparative analysis based on the Bit per Pixel Figure3. Shows the comparative analysis based on the Peak Signal to Noise RatioFigure4. Shows the comparative analysis based on the Mean Square Error. On the basis of comparative analysis of figure I analysis of Huffman coding gives better compression ratio for .JPG images. Figure 2.shows the analysis of Huffman coding gives better Bit Per Pixel for the .PNG image. Figure3. Shows the analysis of SPIHT method gives better Peak signal-to-noise ratio for .PNG images .Figure 4.shows the analysis of EZW

method gives the better Mean Square Error for .PNG images.

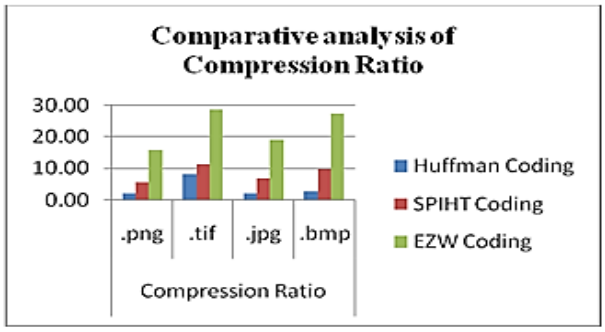

Figure 1: Comparative analysis of Compression ratio

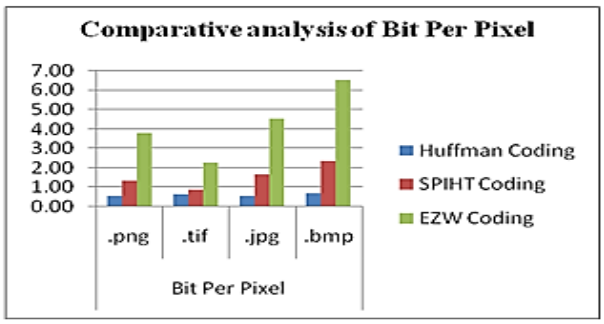

Figure 2: Comparative analysis of Bit per Pixel

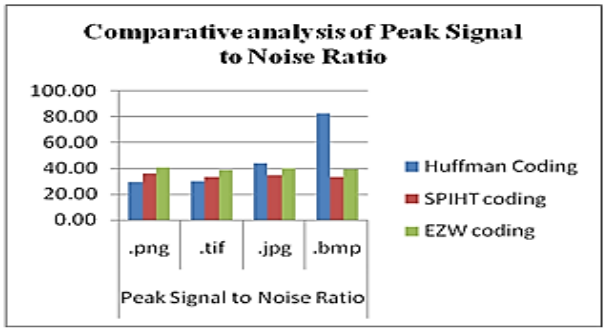

Figure 3: Comparative analysis of Peak Signal to Noise Ratio

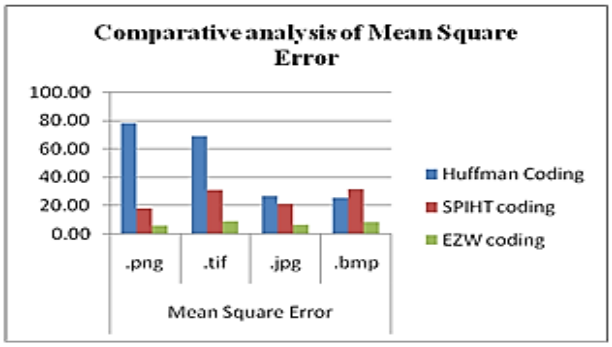

Figure 4: Comparative analysis of Mean Square Error

VII.CONCLUSION

In this paper, the comparison of the three lossless image compression methods such as, EZW, SPHIT and Huffman coding various types of images (binary images, grey level and RGB images) are processed. Comparative analysis of above mentioned techniques is given based on the compression ratio, Peak Signal to Noise Ratio (PSNR), Bits per Pixel (BPP) and Mean Square Error (MSE) were measured by each technique. After experiment of above techniques the Huffman coding gives better compression ratio for JPG images and SPIHT method gives better Peak signal-to-noise ratio for PNG images and Huffman coding gives better Bit Per Pixel for the .PNG image. EZW method gives the better Mean Square Error for .PNG images .In future work, the compression techniques will be used and compared over a large data set of images and also on video files.

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