An Efficient Hybrid Image Compression Scheme based on Correlation of Pixels for Storage and Transmission of Images

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ABSTRACT
Imaging applications generate large volumes of data leading to challenges for transmission and storage**.** In this paper a novel hybrid image compression technique for efficient storage and delivery of data is proposed. It is based on decomposing the data using daubechies-4 wavelet in combination with the lifting scheme and entropy encoding. This scheme is concerned with the compression ratio, bits per pixel and peak signal to noise ratio. Experimental results illustrate that the proposed scheme is efficient and feasible in terms of compression ratio, bits per pixel and peak signal to noise ratio.

Keywords
Hybrid image compression, daubechies-4 wavelet, lifting scheme, entropy encoder.

1. INTRODUCTION
Even though the memory capacities of computers have increased as new technologies are emerging, the requirement for more storage space is also increasing as more data are needed to be stored. In the case of image data, the spatial and colour resolutions are increased for the betterment of image quality, thus requires more space to store images. Image compression either lossy or lossless is one of the solutions to meet the storage requirements.

Some of the related works carried out in hybrid image compression incorporated different compression schemes like predictive vector quantization and discrete cosine transform domain vector quantisation in a single image compression. But the proposed method differs from these techniques by combining both lossy and lossless techniques.

In the proposed method a hybrid compression is performed that combines the lossy and lossless compression techniques. This gives a balance on compression ratio and peak signal to noise ratio by preserving the vital information.

2. PROPOSED WORK
There are many lossless and lossy image compression techniques available. In order to construct the proposed hybrid image compression technique, the existing daubechies wavelet transform, lifting scheme decomposition and Huffman coding techniques are combined.

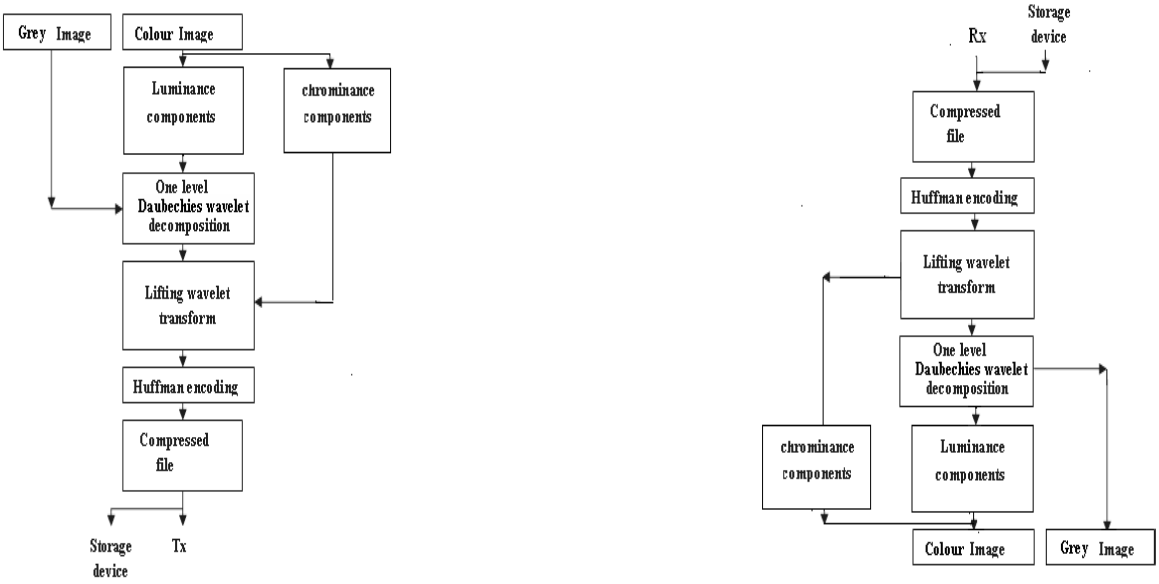
In the different type of wavelet transforms, Daubechies wavelets[3] are more useful in compression and hence used in the proposed method. Followed by the wavelet transform which is a lossy compression technique, lifting technique[1][2] is used in the proposed method. The integer-to-integer property along with the reversibility property makes the lifting scheme ideal for lossless image compression. This structure consists of one split stage and one or more predict and update stages [4]. It has been shown that an integer version of every wavelet transform employing finite filters can be built with a finite number of lifting steps consisting of several stages [5].

The resultant coefficients from the lifting scheme are encoded by an entropy encoder which is a lossless data compression scheme. One such type of entropy encoder is the Huffman encoder.

The block diagram of the proposed work is shown in figure 1(*a*) and (*b*). In the proposed method of image compression, the grey image or a colour image can be compressed.

The colour image is converted to luminance and chrominance components first and the luminance component is decomposed by one level daubechies-4 wavelet transform. The wavelet coefficients and chrominance component are subjected to the lifting wavelet transform using Cohen daubechies filter coefficients. The grey image can be directly subjected to the daubechies-4 wavelet transform and then to the lifting scheme. Then all the coarse and detail coefficients are encoded by Huffman encoding technique to obtain the compressed file.

To reconstruct the original image, the compressed file is decoded first. Then the decoded image is subjected to inverse lifting scheme. The obtained luminance coefficients are inverse transformed by the daubechies-4 wavelet. The resultant values and chrominance are combined to form the original colour image. The grey image is obtained from the inverse lifting scheme and inverse daubechies-4 wavelet transform.



(a) (b)

Figure 1(a).Block diagram of compression steps of the proposed compression method (b).Block diagram of reconstruction steps of the proposed compression method

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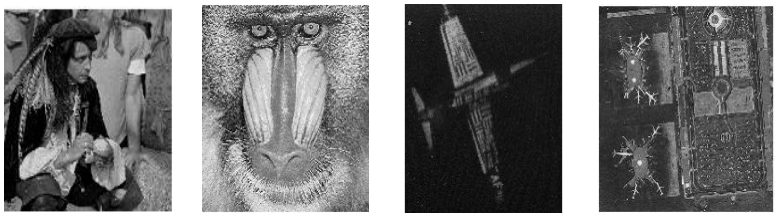
3. RESULTS

The results obtained from the implementation of the proposed method are shown in tables 1 and 2. The hybrid image compression using daubechies wavelet and lifting scheme with huffman coding is implemented according to the description in section 2 and tested with a set of eight grey and colour images as shown in figure 2.



(a) **(b)** **(c)** **(d)**

(e) **(f)** **(g)** **(h)**

Figure 2. Original images (a) Man(b) Mandrill (c) Airplane (d) Airfield (e) Lena (f) Baboon (g) Lena (h) Pepper

Compression ratio(CR), bits per pixel(BPP), and peak signal to noise ratio (PSNR) are calculated for comparing the performance of the proposed method with the other methods namely lossless compression method CABAC and the lossy methods JPEG and JPEG2K as per the following representations**:**

$$CR = \frac{\text{Original image size in bytes}}{\text{Compressed image size in bytes}}$$

with X_{ij} and Y_{ij} are the original and reconstructed images respectively.

$BPP = \frac{24}{CR}$: for colour images

$BPP = \frac{8}{CR}$: for grey images

$PSNR = 10\log_{10}\frac{255^2}{MSE}$

Where

$MSE = \frac{1}{N\times M}\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}(X_{ij} - Y_{ij})^2$

Table 1. Compression size for different compression methods for the PSNR of the proposed method.

Images	PSNR(dB)	Compression Size(Bytes)			
	Proposed	Proposed	CABAC	JPEG	JPEG2K
Man(1024x1024=1048576)	37.36	60125	287472	383317	303791
Mandrill(512x512=262144)	35.19	29316	116516	146887	123156
Airplane(1024x1024=1048576)	35.29	22080	200336	272367	220193
Airfield(1024x1024=1048576)	36.24	60249	335121	466008	366807
Lena(512x512=262144)	38.65	22666	60551	88309	65370
Baboon(480x500x3=720000)	36.33	180458	244599	273032	244599
Lena(512x512x3=786432)	37.42	99178	125581	221107	117649
Pepper(512x512x3=786432)	36.57	114955	125958	227784	133688

From the table 1, we can observe that the compressed image size in terms of bytes is lesser for the proposed compression method compared to the lossless CABAC and lossy JPEG and JPEG2K image compression methods. This infers to higher compression ratio for the proposed method compared to other methods mentioned above.

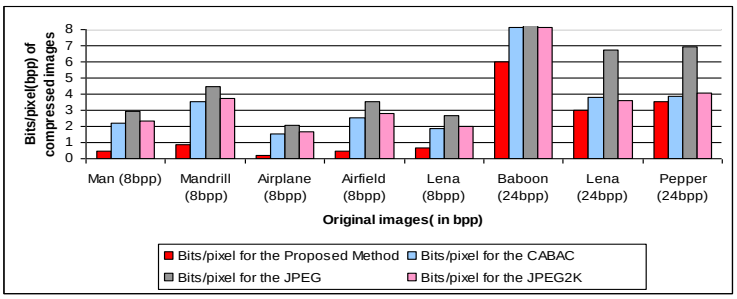


Figure 3. Bar chart representation of Bits/pixel for original images Vs compressed image

Table 2 Bits/pixel for different compression methods for the PSNR of proposed method

Images	PSNR(dB)	Bits/Pixel			
	Proposed	Proposed	CABAC	JPEG	JPEG2K
Man(1024x1024=1048576)	37.36	0.46	2.19	2.92	2.32
Mandrill(512x512=262144)	35.19	0.89	3.56	4.48	3.76
Airplane(1024x1024=1048576)	35.29	0.169	1.53	2.08	1.68
Airfield(1024x1024=1048576)	36.24	0.45	2.56	3.56	2.8
Lena(512x512=262144)	38.65	0.69	1.85	2.69	1.99
Baboon(480x500x3=720000)	36.33	6.015	8.15	9.1	8.15
Lena(512x512x3=786432)	37.42	3.027	3.83	6.75	3.59
Pepper(512x512x3=786432)	36.57	3.51	3.84	6.95	4.08

Also in table 2 and in figure 3, we can observe that the bits per pixel required for the proposed image compression method is less

than the other compression methods. The values in both the tables 1 and 2 are compared with respect to the PSNR of the proposed method. The values for compression size and bits per pixel are tabulated in tables 1 and 2 for the PSNR values of CABAC, JPEG and JPEG2K that are closer to the PSNR value of the proposed method.

The PSNR values for the proposed method and the other methods are close to each other as shown in figure3. In figures 3 and 4, it is inferred that bits per pixel for the proposed is lesser with the peak signal to noise ratio for the proposed method is same as that of the other methods for all the eight images.

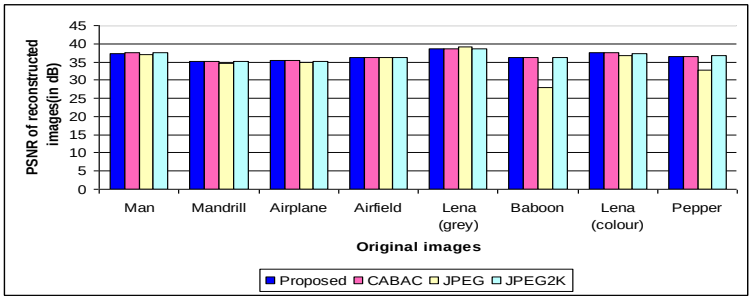


Figure 4. Bar chart representation of PSNR values for different techniques

4. CONCLUSION

From the results, it is inferred that the proposed image compression method "An efficient hybrid image compression scheme based on correlation of pixels for storage and transmission of images" produces higher compression ratio with lesser number of bits per pixel for the same PSNR values of CABAC, JPEG and JPEG2K standards. The proposed method compresses better for both colour and grey images. It works well for the images of different sizes.

The number of colours and the correlation among the pixels in images affects the compression ratio and bits per pixel in the proposed method. The image decomposes in to coarse and detail components. Coarse components have less correlation whereas the detail components have more correlation. So huffman encoder encodes the coarse components with more number of bytes and the detail components with lesser number.

The proposed method gives higher compression ratio compared to the lossy image compression standards and similar peak signal to noise ratio as that of lossless method. Higher compression ratio infers to higher compression performance. This method combines the qualities of both lossless and lossy image compression methods. So the proposed method has efficient storage of images and transmission with perfect reconstruction capability.

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6. REFERENCES

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