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Image Compression By Hybrid Transformation Technique

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Abstract— Now a day, hybrid transformation techniques are in fashion because of limitations of individual transformations. So in my paper I have used SPIHT-DCT for image compression. Results will be checked on PSNR scale. Higher PSNR means good compression quality. Target images will be categorised as- low key image, high key image and medium key image, depending upon their histogram. Our algorithm works best on which type of image is analysed with bar graph.

Keywords— DCT, SPIHT, PSNR, Bar Graph, Compression Quality

I. INTRODUCTION

Image compression is the application of Data compression on digital images. The objective of image compression is to reduce redundancy of the image data in order to be able to store or transmit data in an efficient form. Image compression can be lossy or lossless. Lossless compression is sometimes preferred for artificial images such as technical drawings, icons or comics. This is because lossy compression methods, especially when used at low bit rates, introduce compression artifacts. Lossless compression methods may also be preferred for high value content, such as medical imagery or image scans made for archival purposes. Lossy methods are especially suitable for natural images such as photos in applications where minor loss of fidelity is acceptable to achieve a substantial reduction in bit rate. The lossy compression that produces imperceptible differences can be called visually lossless. Run-length encoding and entropy encoding are the methods for lossless image compression. Transform coding, where a Fourier-related transform such as DCT or the wavelet transform are applied, followed by quantization and entropy coding can be cited as a method for lossy image compression. Nowadays, DCT [1],[3],[4],[5] and DWT[1],[3],[7] are the most popular techniques for image compression. Both techniques are frequency based techniques, not spatial based. Both techniques have its' own advantages and disadvantage. Like DWT gives better compression ratio [1],[3] without losing more information of image but it need more processing power. While in DCT need low processing power but it has blocks artifacts means loss of some information. Our main goal is to combine both techniques and comparing their results. Below is the summarised discussion of DCT compression and SPIHT compression techniques along with their limitations.

II. DISCRETE COSINE TRANSFORM

The discrete cosine transform is a fast transform that takes a input and transforms it into linear combination of weighted basis function, these basis functions are commonly the frequency, like sine waves. It is widely used and robust method for image compression; it has excellent energy compaction for highly correlated data, which is superior to discrete fourier transform and walsh hadamard transform.

The DCT first breaks the image into 8*8 block size and then apply quantization on these blocks, followed by compression algorithm as shown in figure 1.1

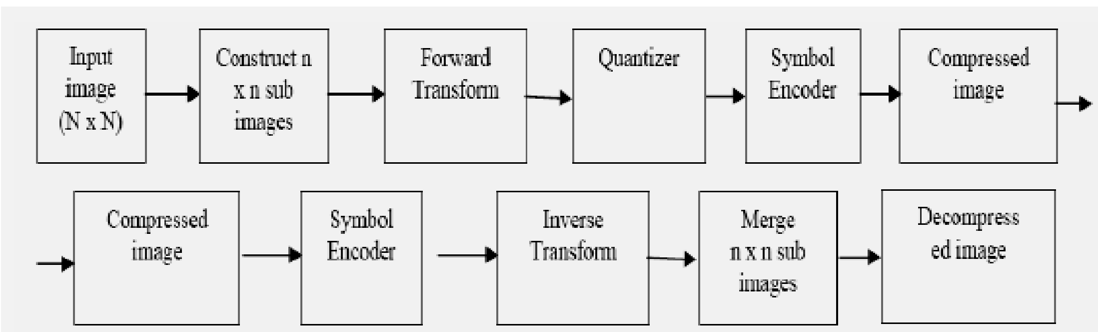


Figure 1.1: Steps for DCT compression

The DC coefficient and all other are AC coefficients. Most of the energy of image is confined to DC coefficient so in compression DC coefficient is removed never. Whereas coefficients with zero magnitude after quantization and vectorization are removed for compression purpose.

A. Limitations of DCT

Figure 1.2 shows the original image and reconstructed images at two different compression level using 2- D DCT. For the lower compression ratio, the distortion is unnoticed by human visual perception, which can be seen in Figure 1.2-(b). In order to achieve higher compression it is required to apply quantization followed by scaling to the transformed coefficient. For such higher compression ratio DCT has following two limitations.

1. *Blocking artifacts*: Blocking artifacts is a distortion that appears due to heavy compression and appears as abnormally large pixel blocks. For the higher compression ratio, the noticeable "blocking artifacts" across the block boundaries cannot be neglected. The example of appearance of blocking artefact due to high compression is shown in Figure 1.2-(c).
2. *False contouring:* The false contouring occurs when smoothly graded area of an image is distorted by an aberration that looks like a contour map for specific images having gradually shaded areas [5]. The main cause of the false contouring effect is the heavy quantization of the transform coefficients. An example of false contouring can be observed in Figure 1.3-(c).

(a) (b) (c)

Figure 1.2: Illustration of compression using DCT: (a) Original Image1, *CR* at (b) 88%, (c) 96%

(a) (b) (c)

Figure 1.3: Illustration of compression using DCT: (a) Original Image2, *CR* at (b) 87 %, (c) 97%

Set Partitioning in Hierarchical Trees (SPIHT)

SPIHT (set partitioning in hierarchical trees) algorithm was proposed by Said and Pearlman, which adopts spatial orientation tree structure, and can effectively extract the significant coefficients in wavelet domain. SPIHT has less extremely flexible features of bit stream than JPEG2000, but SPIHT has low structure and algorithm complexity relatively, and supports multi-rate, has high signal-to-noise ratio (SNR) and good image restoration quality, so it is suitable for encoding occasions with a high real-time requirement.

The SPIHT algorithm is essentially a wavelet transform-based encoding technique. Fig 1.5 shows the hierarchical pyramid structure of the wavelet transform. In Fig. 1.5, each pixel has a direct descendants group of 2×2 adjacent pixels except the highest and lowest pyramid levels. The arrows are oriented from the parent node (pixel) to its four direct descendants. Since most energy of an image is concentrated in low frequency region and there is a spatial self-similarity between subbands, the parent node is normally more energy than its descendant nodes. This property is a key element in the SPIHT algorithm.

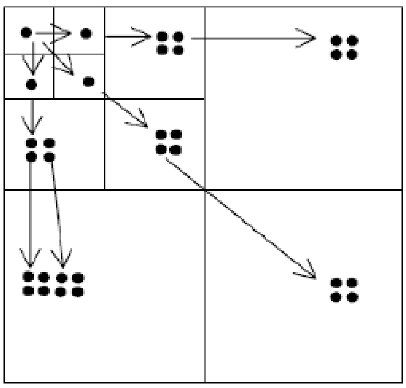
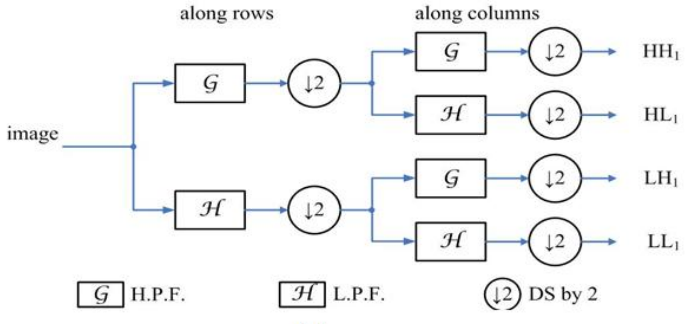


Fig. 1.5: The hierarchical pyramid structure in the wavelet transforms

Wavelet transform breaks an image into four different coefficients each having different energy by use of low pass and high pass filters as shown in figure 1.6.



(a)

Figure 1.6: Wavelet decomposition of an image.

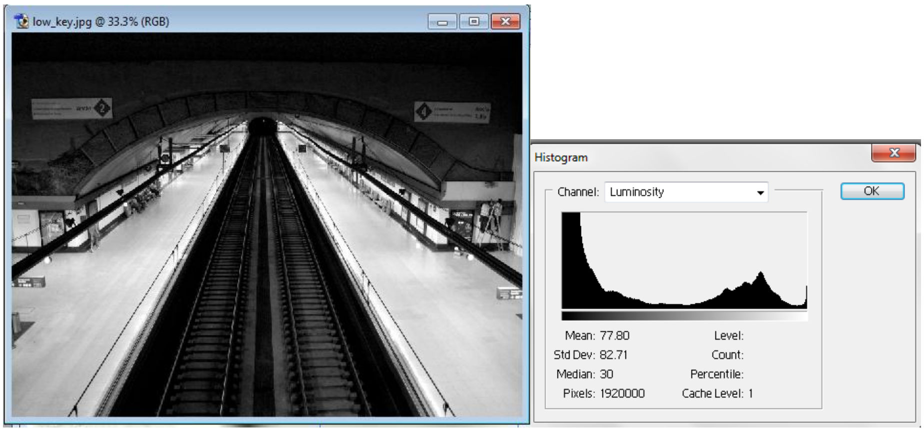
Various filters are used for decomposition of image up to various scales. For image compression approximation coefficient of DWT is considered.

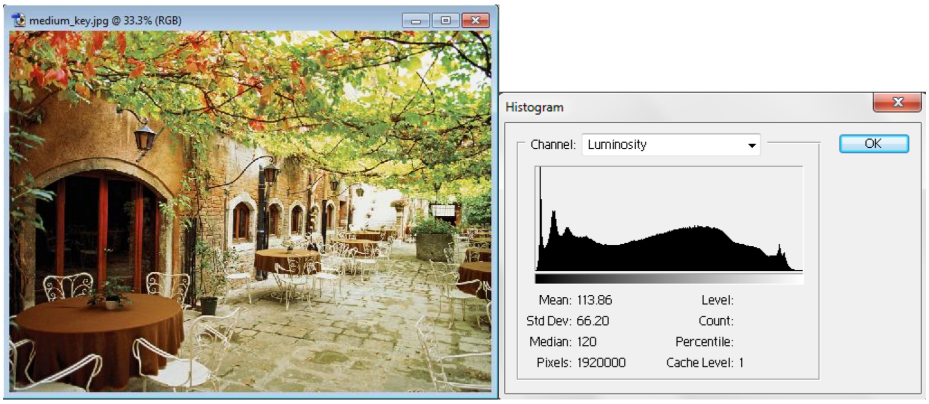
Proposed Work

For the lower compression ratio, the DCT algorithm shows higher energy compaction characteristics and requires less computational complexity as compared to other compression methods: DFT, DST, WHT, and DWT. However, it introduces the blocking artifacts and the false contouring effect at the higher compression ratio. Furthermore it is not a multi-resolution technique. On the other hand, DWT is multi-resolution compression method i.e. an image can be obtained in different resolutions by discarding the detail coefficients and taking only the approximate coefficient. But, the energy compaction characteristic of DWT is less as compared to DCT and requires more computational processor. Hence, multiple transform can be implemented in order to compensate the drawback of each other. In this research work, a hybrid DWT-DCT algorithm has been proposed. DWT wavelet breaks the image into four coefficients. All wavelets have different energy. Its approximation coefficient has highest energy than any other. So for DCT its only approximation coefficient is considered. Our algorithm will be checked for different type of images. For this purpose images are divided into three categories: low key image, medium key image, high key image. Both DCT and SPIHT-DCT algorithm are checked for these three types of images. The result is justified by evaluating the parameter PSNR. Higher will be the value of PSNR, higher will be image quality.

III. RESULTS

For my work images have been categorised into three types: low key, medium key and high key. The histograms for these three types of images are shown in below given figure.





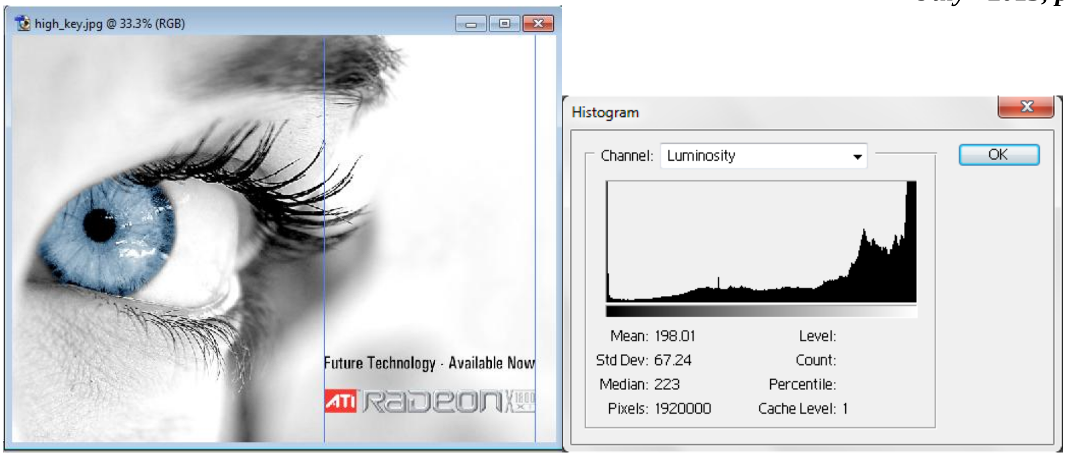


Figure3.1: Low Key Image, Medium Key Image, and High Key Image along with their histograms

The compression of these images is analyzed on the basis of PSNR calculation. Higher the PSNR good is compression quality. Graph for each type of images are shown in below figures.

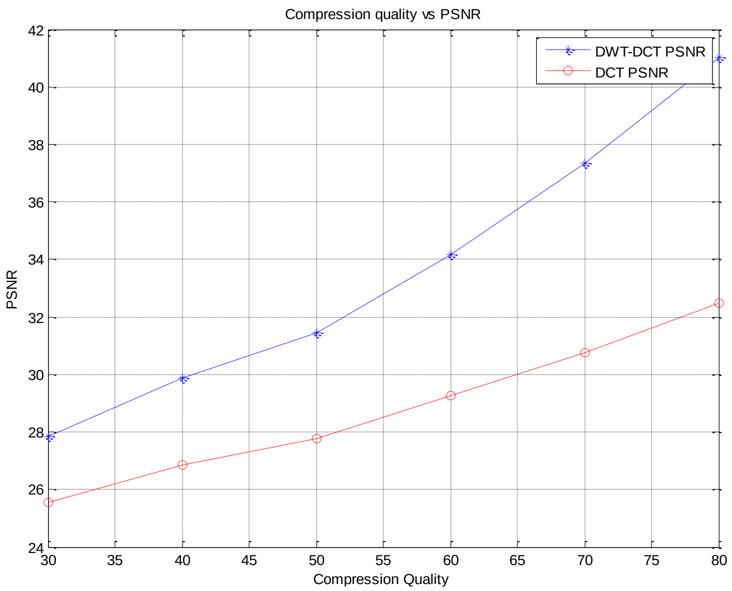


Figure 3.3: PSNR of SPIHT-DCT and DCT for low key image

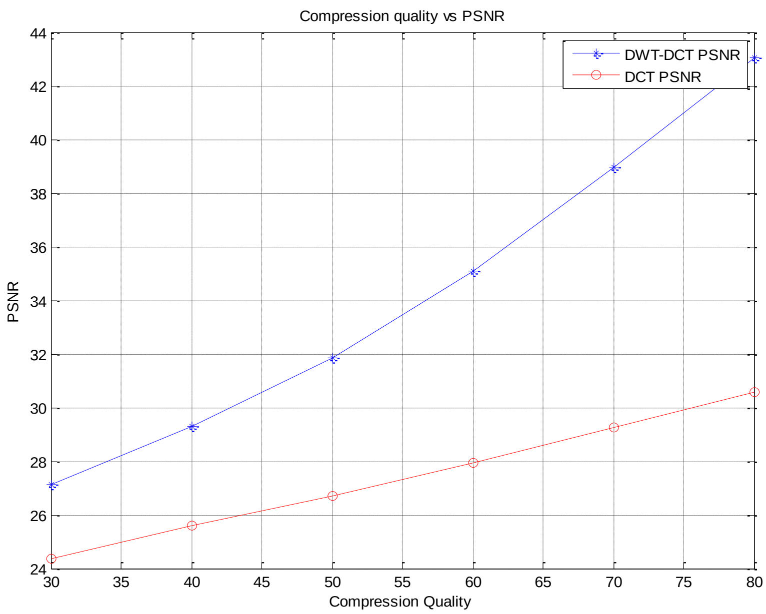


Figure 3.4: PSNR of SPIHT-DCT and DCT for medium key image

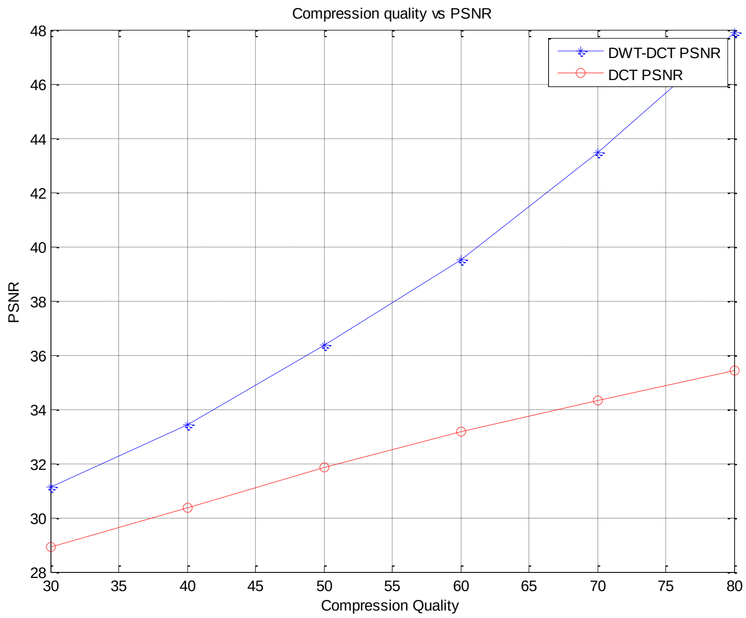


Figure 3.5: PSNR of SPIHT-DCT and DCT for high key image

The table compares the PSNR for every case discussed above.

TABLE I
PSNR FOR BOTH SPIHT-DCT AND DCT

	Low Key Image		**Medium Key Image**		**High Key Image**	
Compression Quality	**DCT**	**SPIHT-DCT**	**DCT**	**SPIHT-DCT**	**DCT**	**SPIHT-DCT**
30	25.5431384	27.845980	24.37453	27.138999	28.907760	31.12902
40	26.8450092	29.865839	25.57548	29.281951	30.352594	33.41967
50	27.7746699	31.442443	26.69578	31.862601	31.869376	36.37014
60	29.2656468	34.169815	27.95137	35.077003	33.169060	39.53158
70	30.7593213	37.357763	29.26873	38.948403	34.331002	43.45133
80	32.4813768	41.019702	30.57330	43.056099	35.425913	47.90943

Above table shows that compression quality for SPIHT-DCT is good because PSNR is high than only DCT. High PSNR depicts good robustness and good quality. For a good compression quality PSNR should be high. Above table and graphs clearly show that PSNR is high for SPIHT-DCT for every type of image. A bar graph showing PSNR for SPIHT-DCT is shown in figure below.

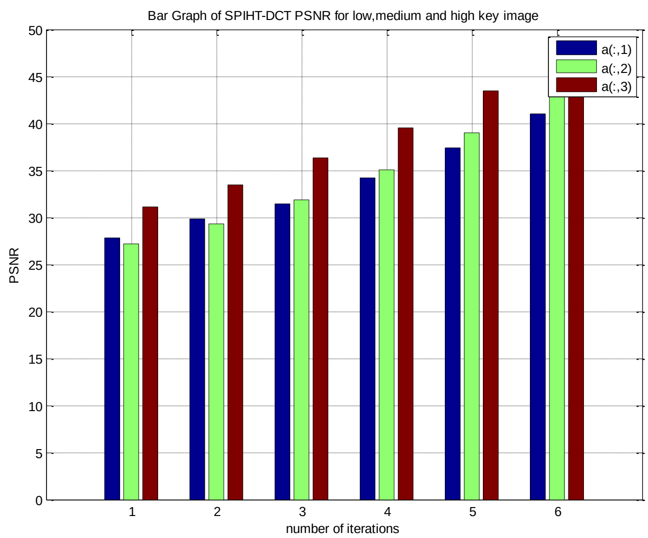


Figure 3.6: Bar graph for SPIHT-DCT PSNR for low key, high and medium key image

IV. CONCLUSION

In my work I have used SPIHT –DCT for compression of an image. SPIHT and DCT both individually have some limitations so in combination those limitations have been overcome. Proposed algorithm shows better results for the high key image as PSNR value is high in that case amongst all. Above bar graph clearly depicts that. Moreover comparison of my proposed work with DCT is also shown in results. That also proves, proposed work is better than individual transformation techniques.

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