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Comparison of Discrete Wavelet and Discrete Cosine Transform for Enhancement of Gray Image

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Abstract: *In this paper comparison of Discrete Wavelet and Discrete Cosine Transform for contrast enhancement of gray image is discussed and implemented using proposed mask. The technique converts the image into DCT domain and the DCT coefficients are modified using proposed mask then the enhanced image is reconstructed using inverse DCT. After comparing enhancement based on DCT with enhancement based on wavelet transform I found that the discrete cosine transform outperforms with better image quality and with highest PSNR value.*

Keywords: Discrete Wavelet transform, Discrete cosine transform

I. INTRODUCTION

Image Contrast Enhancement process plays an important role in enhancing images quality where features are hardly detectable by eye. It improves the visualization of features. Basically contrast is developed due to luminance reflected by two surfaces. In satellite, medical field the contrast enhancement techniques are capable to enhance the images brightness and contrast. Histogram equalization is one the most well-known method for enhancement of images with poor intensity distribution. By enhancing edges of image enhancement of can be done . Multi scale edge enhancement approach, takes all resolution levels into account. MSR softens the strongest edges and keeps the faint edges almost untouched. The strategies are different, but methods allow the user to see details which were hardly distinguishable in the original image, by reducing the ratio of strong features to faint features. The wavelet approach consists of first transforming the image using the dyadic wavelet transform. Then the two wavelet coefficients relative to the horizontal and vertical wavelet bands are modified by multipling by constant at scale and at pixel position. Finally, the enhanced image is obtained by taking the inverse wavelet transform from the modified wavelet coefficients. Wavelet bases present some limitations, because they are not well adapted to the detection of highly anisotropic elements, such as alignments in an image, or sheets in a cube. In DCT approach by modifying DCT coefficients of sub images can enhance the image properly.

II. OVERVIEW OF DWT AND DCT

In this paper, mask in discrete cosine transform domain for enhancing the gray image has been proposed and compared with discrete wavelet transform.

2.1 Discrete Wavelet Transform

The wavelet approach consists of first transforming the image the two wavelet coefficients relative to the horizontal and vertical wavelet bands are modified by scaling. Finally the enhanced image is obtained by taking the inverse wavelet transform from the modified wavelet coefficients. The discrete wavelet transform is based on sub band coding and easy to implement. After transforming, an image is separated into approximations and detail coefficients. Approximate coefficients are high scale, low frequency components of an image. The detail coefficients are low scale, high frequency components. Two-dimensional DWT leads to a decomposition of approximation coefficients at level j in four components: the approximation at level $j + 1$, and the details in three orientations (horizontal, vertical, and diagonal).The following chart describes the basic decomposition steps for images:

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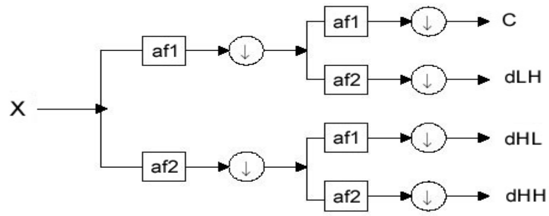

Fig. 1. Decomposition of image

After decomposition approximate and detail coefficients are modified using properly designed scaling factor. Then using inverse transform enhanced image is reconstructed.

LL*m	LH*n
HL*p	HH*q

Fig. 2 DWT scaling factor mask

2.2 Discrete Cosine Transform

The DCT helps to separate the image into parts (or spectral sub-bands) of differing importance (with respect to the image's visual quality). The popular block-based DCT transform segments an image non overlapping block and applies DCT to each block. It gives result in three frequency sub-bands: low frequency sub-band, mid-frequency sub-band and high frequency sub-band. DCT based enhancement is based on two facts. The first fact is that much of the signal energy lies at low-frequencies sub-band which contains the most important visual parts of the image as shown in fig. No.4. The second fact is that high frequency components of the image and it is noise.

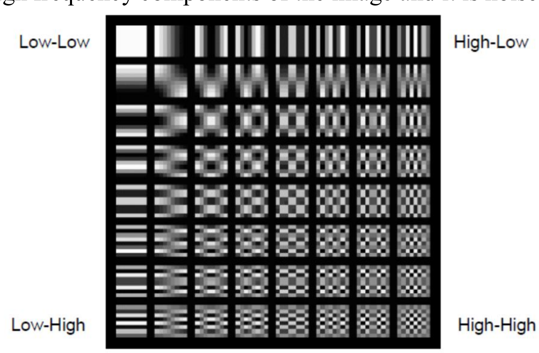

Fig. 3 DCT Coefficients

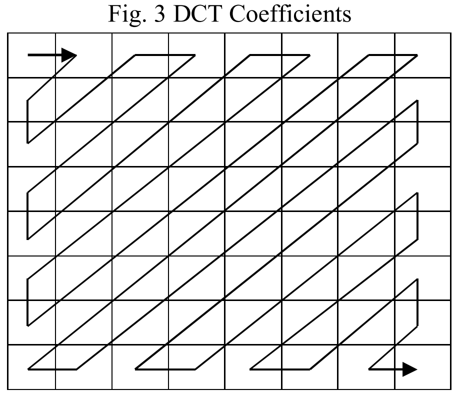

Fig. .4 zigzag ordering of DCT coefficients

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III. PROPOSED METHODOLOGY

In this paper, a technique based on discrete cosine transform and discrete wavelet transform has been proposed and compared for enhancing the contrast of gray images. Discrete cosine transform is applied to extract the features of an image. The DCT converts the spatial domain into frequency domain represented by its DCT coefficients. DCT separates higher and lower frequency components in two parts. The important information is present in low frequency DCT coefficients. Hence separating low and high frequency coefficients and modifying DCT coefficients by multiplying proper scaling factor, a new enhanced gray image is obtained. For obtaining enhanced image from modified coefficients inverse DCT is used. The proposed mask is given below.

m	m	m	m	m	m	m	m
m	m	m	m	m	m	m	n
m	m	m	m	m	m	N	n
m	m	m	m	m	n	N	n
m	m	m	m	n	n	N	n
m	m	m	n	n	n	N	0
m	m	n	n	n	n	0	0
m	n	n	n	n	0	0	0

Fig. 5 DCT 8*8 scaling mask

The following are the steps for proposed technique.
Assume A is a gray image and E' is an enhanced image.
Step1: Read a gray image A.
Step2: Divide the input image into 8*8 non-overlapping sub blocks.
Step3: Apply DCT to each sub block.
Step4: Using proposed mask each sub block DCT coefficients are modified.
Step5: By applying inverse DCT reconstruct the enhanced image E from modified DCT coefficients.

IV. RESULTS AND DISCUSSION

For obtaining better result different scaling factors are analyzed and best scaling factors are used to enhance the image.

4.1 Enhanced Image based on DCT

Fig. No.6 DCT Output for lena.jpg

Lena.jpg	Scaling Factor		For noiseless image		For noisy image	
Sr.no.	**m**	**N**	**PSNR**	**Contrast**	**PSNR**	**Contrast**
1	0.7000	0.8040	24.1805	0.1660	24.3919	0.7229
2	0.8000	0.8080	24.5534	0.2025	24.7919	0.8022
3	0.9000	0.8120	26.2177	0.2406	26.5022	0.8911
4	1.0000	0.8160	51.6302	0.2937	33.6584	1.0030
5	1.1000	0.8200	75.4320	0.3304	42.0890	1.1002

6	**1.2000**	**0.8240**	**93.2853**	**0.3595**	**47.9023**	**1.1794**
7	1.3000	0.8280	Inf	0.3829	51.9566	1.2449

Table 1 DCT Scaling factor analysis

4.2 Enhanced Image based on DWT

Fig. DWT Output for lena.jpg

Lena.jpg	Scaling Factor				For noiseless image	
Sr. no.	**m**	**N**	**p**	**q**	**PSNR**	**Contrast**
1	1.0100	0.7080	1.0100	0.0100	43.1187	0.2856
2	1.0200	0.7160	1.0200	0.0200	44.4010	0.2915
3	1.0300	0.7240	1.0300	0.0300	45.6292	0.2954
4	1.0400	0.7320	1.0400	0.0400	46.8408	0.2987
5	1.0500	0.7400	1.0500	0.0500	48.0922	0.3025
6	1.0600	0.7480	1.0600	0.0600	49.3582	0.3052
7	1.0700	0.7560	1.0700	0.0700	50.6504	0.3095
8	1.0800	0.7640	1.0800	0.0800	52.0282	0.3114
9	1.0900	0.7720	1.0900	0.0900	53.4572	0.3150
10	1.1000	0.7800	1.1000	0.1000	54.9756	0.3216
11	1.1100	0.7880	1.1100	0.1100	56.5583	0.3279
12	1.1200	0.7960	1.1200	0.1200	58.2372	0.3338
13	1.1300	0.8040	1.1300	0.1300	59.9137	0.3384
14	1.1400	0.8120	1.1400	0.1400	61.7487	0.3398
15	1.1500	0.8200	1.1500	0.1500	63.6949	0.3403
16	1.1600	0.8280	1.1600	0.1600	65.5842	0.3431
17	**1.1700**	**0.8360**	**1.1700**	**0.1700**	**67.7647**	**0.3440**
18	1.1800	0.8440	1.1800	0.1800	69.5470	0.3453
19	1.1900	0.8520	1.1900	0.1900	71.3960	0.3466
20	1.2000	0.8600	1.2000	0.2000	73.7188	0.3499

Table 2 DWT scaling factor analysis

V. CONCLUSION

From above results we conclude that for enhancement of gray image discrete cosine transform outperforms better than discrete wavelet transform. Using discrete cosine transform obtained highest PSNR value is 96 dB and the image quality is better than discrete wavelet transform

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