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Compression Ratio based on Smoothing Filter

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Abstract- In this paper, computation of compression ratio based on smoothing filters is presented. The DCT transform is used for compression. Before compressing the image, smoothing filters are applied over the image to blur or smooth the image. The filtering effects in reduction of noise and introduced artifacts during compression process. For certain level of smoothness block is approximated by spectral DC components. Linear filters and nonlinear filters are used for smoothing operation. The method shows there is tradeoff between quality of image and degree of smoothness. The quality of image is measured by minimum mean square error and peak signal to noise ratio.

Index Terms-Signal processing, Image Compression, Transform Coding, Fast Transforms.

1. INTRODUCTION

High quality image requires large space for storage and more time for compression. Thus there is need of compressing the image, but preserving the original information. There is lot of work is already done in the image compression and its algorithms. If compression is performed in frequency domain then much energy is saved because minimum numbers of coefficients are required for same information. The best transform is discrete cosine transform for image compression [1].

Data is compressed prior to the transmission. Images are coded with JPEG, MPEG and H.26x which are suitable for DCT. The encoders and decoders are DCT based. [2] The Filters are used for removing noise present in the image. But this noise removal will make the image smooth. For certain level of smoothness the block can be approximated by spectral DC components. Different Filter is used for removal of different type of noise.

There are different techniques for data compression. Lossless and lossy. In lossless techniques the all the coefficients are preserved hence original reconstructed image is in same size as that of original image. The compression ratio achieved in this technique is less than lossy compression techniques. On the other hand the lossy compression techniques are based on discarding some DCT coefficient and reconstructed image is not exactly same as that of original image. The compression ratio achieved is high. [3]

2. PROPOSED WORK

In this method, the prior to image compression the image is filter with suitable filter mask and then DCT transform is used for compression. There is tradeoff exists between degree of smoothness and quality of image. The choice of smoothness or standard deviation such that it should not exceed the mean (threshold) of image. The maximum compression ratio is dependent on standard deviation and threshold value.

3. SMOOTHING OF IMAGE

The smoothness depends on standard deviation factor (Sigma). The criteria for smoothness are standard deviation should be less than threshold.

$$\sigma = \sqrt{\frac{1}{N^2}\sum_{i=1}^{N}\sum_{j=1}^{n}(P(i,j)-\mu)^2} \quad \text{-----(1)}$$

μ = mean of image
σ = standard deviation
N = No. or rows and column

$$\mu = \frac{1}{N^2}\sum_{i=1}^{N}\sum_{j=1}^{n}P(i,j) \quad \text{-------(2)}$$

For testing purpose there are other criteria such as MSE mean square error and PSNR peak signal to noise ratio.

The formula for MSE is given by,

$$MSE = \frac{1}{Kl}\sum_{i=1}^{N}\sum_{J=1}^{N}(f1(k,l)-f2(k,l))^2 \quad \text{---(3)}$$

Where ,

f1= input image
f2= compressed image

The PSNR formula is given by

$$PSNR = 20 * log_{10}\,(255/\sqrt{MSE})\text{-----(4)}$$

4. RESULTS

For testing or results the standard gray scale test images are used. Each image is of 256*256 pixels size. Each image is applied with filter for compression. Following are test images

Figure 1: Cameraman.

Figure 2: Lena

The Gaussian filter is used to smooth the image, with controlling factor of standard deviation (σ). The following result shows that increase in deviation the compression ratio decreases.

Table 1: Using Gaussian filter

Image	Sigma	CR	PSNR
Cameraman	0.2	6.75	116.16
	0.4	6.18	90.84
	0.6	3.34	79.17
	1.0	1.91	74.35
	2.0	1.49	70.87
	4.0	1.34	68.50
Lena	0.2	1.63	111.11
	0.4	1.75	94
	0.6	2.02	83.30
	1.0	1.90	78
	2.0	1.56	73.69
	4.0	1.40	70.44

The average filter is taken in different sizes. More size, the smoothness depends on more number of connected pixels. As the size of filter mask increases, the compression ratio decreases. The results are shown in table 2.

Table 2: Using average filter

Image	Size	CR	PSNR
Cameraman	3×3	2.30	74.17
	5×5	1.80	71.22
	7×7	1.60	69.88
Lena	3×3	2.13	78.44
	5×5	1.77	74.53
	7×7	1.62	72.67

Disc filter is used to smooth the image; the radius of Disc decides the mask size of filter. As the radius increases the smoothness increases and compression ratio decreases. The table 3 shows the results.

Table 3: Using Disc filter

Image	Radius	CR	PSNR
Cameraman	1	2.73	77.68
	2	1.93	73.10
	3	1.68	71.09
	4	1.56	69.97
Lena	1	2.11	81.85
	2	1.89	76.68
	3	1.71	74.11
	4	1.62	72.61

The median filter is nonlinear filter. This is also depends on size. As the size of filter increases the smoothness increases and compression ratio decreases. The table 4 shows the results

Table 4: Using median filter

Image	Size	CR	PSNR
Cameraman	3×3	3.17	75.37
	5×5	2.35	71.94
	7×7	2.05	70.51
	9×9	1.90	69.74
Lena	3×3	3.01	80.38
	5×5	2.63	76.21
	7×7	2.37	74.13
	9×9	2.18	72.65

5. CONCLUSION

The results show that different filter with different smoothing factor results in different compression ratio for same image. In all filter there is tradeoff between the degree of smoothness and quality of image. For the optimal compression ratio, the DCT coefficients are chosen based on threshold value. This threshold is taken as average of image. The best compression results are obtained in Gaussian filter for both the test images compared to other filters.

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