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PERFORMANCE ANALYSIS OF VARIOUS TRANSFORM CODING TECHNIQUES USING PSNR VALUES

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Abstract

The major problem in handling the image files of photographic quality is a disk space. In such programs, images used are to be compressed for some purpose or transit and then decompressed to obtain the original quality like images. The various compression techniques were used for the above purpose. Transform coding is the base for all the compression techniques. In the transformed domain, the coefficients corresponding to the signals are subjected to quantization and bit-allocation. We could achieve a compression of 92.9% with 0.5 bits per pixel. The performance of the transform coding schemes is evaluated by computing the peak signal-to-noise ratio (PSNR). Hence, this paper analysis the performance of PSNR values over various types of transform coding techniques. For this purpose, the PSNR value is calculated for every transform coding techniques on the image of various sizes and quality factors. Based on this analysis, one can easily select the best transform coding scheme for various image sizes.

Key words : Image, Compression, PSNR, Transform

1. INTRODUCTION

Compression is the process of reducing the amount of data required to represent a given image[1]. In digital image compression, data redundancy is a key issue. Data compression techniques can be classified into two areas. They are Error Free Compression or Lossless Compression and Error Compression or Lossy Compression. In this paper, an experiment is illustrated to find out the best technique for image compression by calculating and analysing the PSNR values according to the various sizes of sub images and quality factors. Since PSNR is mostly meant for lossy compression technique, here an experiment is made with various transform coding for lossy compression techniques. For this, all the transform coding techniques were adapted by this program. Since various transform coding techniques are used for digital image compressions[2], this paper calculates the PSNR value for every transform. The performance analysis can be obtained by considering those PSNR values because PSNR values are the performance measure of the transform coding techniques. This paper is organized as follows : Section 1 gives the introduction of the proposed work. Section 2 discusses about the transform coding techniques. Next section (Section 3) illustrates the proposed experiment to calculate the PSNR value for various transforms. Section 4 discusses the result of the proposed work.

2. TRANSFORM CODING TECHNIQUES

Transform coding is a technique in image compression. In this technique, a linear reversible transform is used to map the image into a set of transform coefficients. Then the coefficients are quantized and coded. There are two major sections of transform coding technique exist. They are

(a) Encoding
(b) Decoding

All the transform encoding steps adapted by local image content is called an adaptive transform coding,. Another one called non adaptive transform coding which one is the fixed for all subimages [3]. The purpose of the transformation process is to pack as much as pixels of each subimage possible into the smallest number of transform coefficients. Then the quantization method is selected to eliminate the coefficients which are carrying least information. These coefficients will not have much impact on the reconstructed subimage quality. The encoding is the process for coding the quantized coefficients.

2.1 Various Types of Transforms

The various types of transformation techniques available are :

1. Discrete Cosine Transform (DCT)
2. Orthogonal Polynomial Transform (OPT)
3. Fast Fourier Transform (FFT)
4. Karhunan – Loeve Transform (KL)
5. Slant Transform
6. Hadamard Transform
7. Walsh Transform
8. Haar Transform

The major characteristic of all these technique is to compacts the image energy to a few of the transform domain samples. Out of all the above transforms, only four of them viz., DCT, Haar, Walsh and Slant are considered for this experiment.

3. EXPERIMENT

3.1 Peak signal-to-noise ratio (PSNR)

Peak signal-to-noise ratio (PSNR) is an engineering term which is the ratio between the maximum possible power of a signal to the power of corrupting noise that affects the fidelity of its representation. Since many signals are having very wise dynamic range, PSNR is expressed in terms of logarithmic decibel unit.

PSNR is most commonly used to measure the quality of reconstruction of lossy compression technique. Here, signal is the original data and the noise is the error created by the compression. When comparing the compression codec, PSNR is an approximation to human perception of reconstruction quality of the image. Hence, higher the PSNR value indicates the higher quality of the reconstruction of an image. One has to be very careful with the validity range of this metric; it is conclusively valid when it is used to compare results from the same codec and same content [4]. The coding was written in C.

3.2 Calculation of PSNR

The peak signal-to-noise ratio (PSNR) which is computed using the formula

$$PSNR = 10\log_{10}\frac{(255)^2}{e_{ms}^2} \quad \text{..... (1)}$$

where the average mean-square error, e_{rms} is,

$$e_{rms}^2 = \frac{1}{NM}\sum_{i=1}^{N}\sum_{i=1}^{M} E(u_{i,j} - u'_{i,j})^2 \quad \text{..... (2)}$$

where $\{u_{i,j}\}$ and $\{u'_{i,j}\}$ represent the N x M original and reproduced images respectively.

4 RESULTS AND DISCUSSIONS

By considering the quality factor and subimage sizes, the results are tabled below. The table 1 and 2 shows the comparison of PSNR values for the same sub image size 4 and with the quality factors as 10 and 20 respectively. Similarly, the tables 3 and 4 shows the comparison of PSNR values for the same sub image size 8 and with the quality factors as 10 and 20 respectively.

Table 1 : Comparison of PSNR values with quality factor 10 and Image size 4

Transform Techniques	PSNR in dB
DCT	26.298
HAAR	27.668
WALSH	25.574
SLANT	24.700

Table 2 : Comparison of PSNR values with quality factor 20 and Image size 4

Transform Techniques	PSNR in dB
DCT	22.792
HAAR	22.948
WALSH	22.328
SLANT	20.641

Table 3 : Comparison of PSNR values with quality factor 10 and Image size 8

Transform Techniques	PSNR in dB
DCT	23.330
HAAR	25.106
WALSH	23.038
SLANT	20.718

Table 4 : Comparison of PSNR values with quality factor 20 and Image size 8

Transform Techniques	PSNR in dB
DCT	20.070
HAAR	21.37
WALSH	19.630
SLANT	17.853

The corresponding charts are also drawn and are labeled as Figures 1 to Figures 4 respectively as shown below :

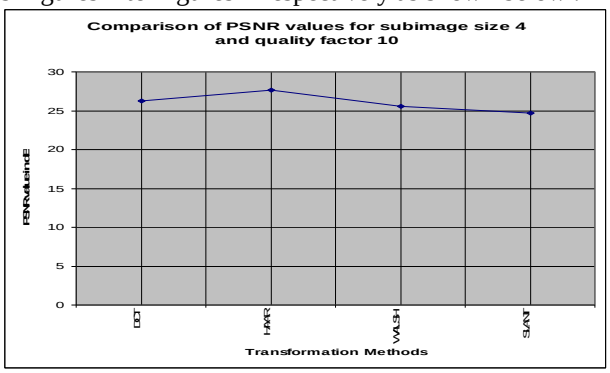

Figure 1 : Comparison of PSNR value for subimage size 4 and quality factor 10

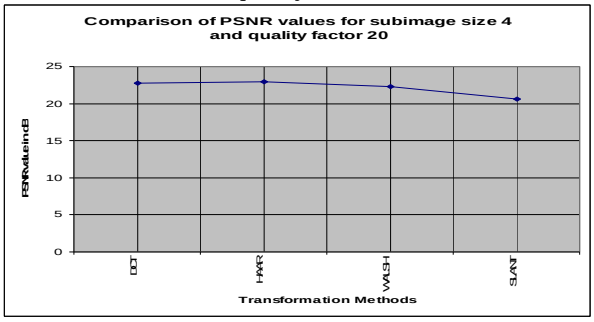

Figure 2 : Comparison of PSNR value for subimage size 4 and quality factor 20

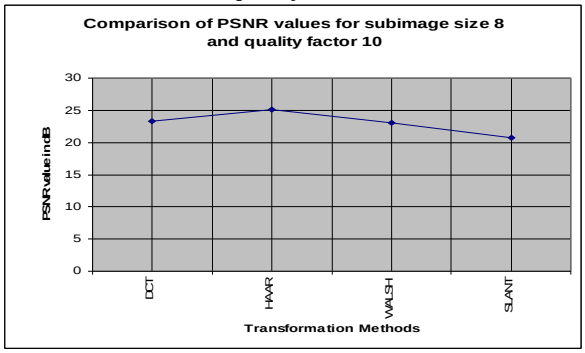

Figure 3 : Comparison of PSNR value for subimage size 8 and quality factor 10

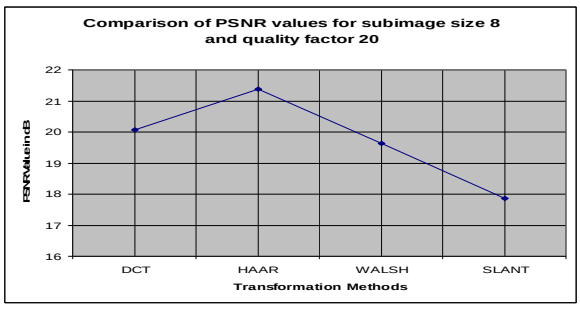

Figure 4 : Comparison of PSNR value for subimage size 8 and quality factor 20

From the results, it is known that, the compression ratio of an image is directly proportional to their PSNR values on every transform coding techniques. That is, if the PSNR value increases the ratio of compression is also increases and this is in evident to the fact that higher the PSNR value will provide the high quality on reconstructed image. From this, the PSNR value can be arranged in descending order to get the order of best compression techniques. The following tables labeled from Table 5 to Table 8 are the rearrangement of Tables from Table 1 to Table 4 in descending order of PSNR values.

Table 5 : Descending order of PSNR values from Table 1

Transform Techniques	PSNR in dB
HAAR	27.668
DCT	26.298
WALSH	25.574
SLANT	24.700

Table 6 : Descending order of PSNR values from Table 2

Transform Techniques	PSNR in dB
HAAR	22.948
DCT	22.792
WALSH	22.328
SLANT	20.641

Table 7 : Descending order of PSNR values from Table 3

Transform Techniques	PSNR in dB
HAAR	25.106
DCT	23.330
WALSH	23.038
SLANT	20.718

Table 8 : Descending order of PSNR values from Table 4

Transform Techniques	PSNR in dB
HAAR	21.37
DCT	20.070
WALSH	19.630
SLANT	17.853

From the above tables it is shown that, with the selection of subimage sizes as 4 and 8 and with the quality factors 10 and 20, HAAR transformation is having the highest performance than the other three. This study is performed with certain quality factors and subimage sizes. The same can be extended for other values also to find out the best compression techniques among the various subimage sizes.

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