TRANSFORM CODING AND WAVELET/SCALAR QUANTIZATION FOR IMAGE COMPRESSION TECHNIQUES

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Abstract

Image compression techniques are concerned with reduction of the number of bits required to store or transmit images without any appreciable loss of information.The signal is separated (approximately) into frequency bands for efficient coding. The subband signals are quantized such that the objective measure is maximized.

I. INTRODUCTION

Image compression is used to transmit or to store an image.Among various compression techniques transform coding is a favorite technique. Image compression is achieved by exploiting redundancies in the image. These redundancies could be spatial, spectral, or temporal redundancy.

- Spatial redundancy is due to the correlation between neighboring pixels.
- Spectral redundancy is due to correlation between different color planes.
- Temporal redundancy is due to the correlation of different frames in a sequence of images such as in videoconferencing applications or in broadcast images.[3]

In transform coding, a reversible, linear transform (such as the Fourier transform) is used to map the image into a set of transform coefficients, which are then quantized and coded. For most natural images, a significant number of the coefficients have small magnitudes and can be coarsely quantized (or discarded entirely) with little image distortion. Transform coding systems based on the Karhunen-Loeve Transform (KLT),Discrete Fourier Transform(DFT), Discrete Cosine Transform(DCT), Walsh-Hadamard Transform(WHT), and various other transforms have been constructed and/or studied extensively. The choice of a particular transform in a given application depends on the amount of reconstruction error that can be tolerated and the computational resources available.[2] In the past decade, the discrete cosine transform (DCT) has been most popular because it provides optimal performance and implemented at a reasonable cost. Now discrete wavelet transform (DWT) is widely used because of its ability to solve the blocking effect introduced by DCT and its suitability in multi-resolution analysis.[1]

II. TRANSFORM CODING

Fourier transform for a given image had larger values clustered at the lower frequencies. These decreased rather rapidly with increasing frequencies. This characteristic, which was effectively used to our advantage in filter design, can also be used in image compression.

The DCT is slightly optimal in its energy packing efficiency to the KLT; because of its computational efficiency it has evolved as the standard in image compression. Transform coding is not applied over the whole image at once, but rather over fixed blocks each of size, usually 8×8 or 16×16.The reasons are as follows:

1. The transform of small blocks is much easier to compute than for the complete image.
2. The correlation between pixels is less between distant pixels than between neighboring pixels.[3]

III. WAVELET/SCALAR QUANTIZATION

Most of the compression occurs in the quantization stage, which operates in the transform domain on individual pixels (scalar quantization)[4].The resolution or code rate,r, of a scalar quantizer as $r = \log_2 N$ which measures the number of bits needed to uniquely specify the quantized value .Specifically, if r is an integer, one could assign to each y_i a unique binary $r-$tuple (by coding the values y_i into binary vectors in an invertible manner).Here the output values , y_i ,are sometimes referred to as output levels, output points, or reproduction values. N is finite so that a finite number of binary digits is sufficient to specify the output value.[5]

Wavelet/Scalar quantization (WSQ) algorithm chosen for JPEG standard would win, but at compression of 15:1 and 20:1 the blocking from the DCT was severe. Ridges that are separated in the true image were found to merge during compression. A ridge has the same position within each subband, when filters have zero phases. This is unacceptable.It did not happen for wavelets. The linear phase 9/7 filter bank appeared just in time to be compared with the Daubechies 8/8 bank, and 9/7 was better for two main reasons:

1. Symmetric (and symmetric extension at the boundaries)
2. The image contents do not shift between the subbands.[6]

IV. EXPERIMENTAL RESULTS

The original rectangular image is shown in Figure. The Barbara image is rectangular images. The size of Barbara is 512×512. The 9/7 filter shown in Table is used, and the symmetric extension is applied to the image edges. The 9/7 filter is known in MATLAB as bior4.4. The number of decomposition scale is varied from image to image, depending on their sizes.

TABLE 1 FILTER COEFFICIENTS OF 9/7 FILTER. $h[-n]=h[n]$ AND $g[-n]=g[n]$

	$n=0$	$n=1$	$n=2$	$n=3$	$n=4$
$h[n]$	0.8526987	0.3774027	-0.1106240	-0.0238493	0.0378288
$g[n]$	-0.7884849	0.4180924	0.0406898	-0.0645391	-

TABLE II

Level = 1

	Initial	Kept
A1	1742	17424
D1	5227	52272
S	6969	69696

TABLE III

Level = 2

	Initial	Kept
A2	4900	4900
D2	1470	14700
D1	5227	52272
S	7187	71872

TABLE IV

Level = 3

	Initial	Kept
A3	1521	1521
D3	4563	4563
D2	1470	14700
D1	5227	52272
S	7305	73056

TABLE V

Level = 4

	Initial	Kept
A4	576	576
D4	1728	1728
D3	4563	4563
D2	1470	14700
D1	5227	52272
S	7383	73839

TABLE VI

Level = 5

	Initial	Kept

A5	256	256
D5	768	768
D4	1728	1728
D3	4563	4563
D2	1470	14700
D1	5227	52272
S	7428	74287

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