COMPRESSION OF IMAGE BY USING CONDITIONAL SPLIT LATTICE VECTOR QUANTIZATION METHOD

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Abstract

Application like Transmission and storage in data bases image compression is essential. In this paper propose a conditional split lattice vector quantization technique. First, use a discrete wavelet transformation to obtain a set coefficient of image. Then quantized approximate coefficients using conditional split lattice vector quantization method. After quantization reconstruct the image. calculated PSNR and MSE for different images sample by using conditional split lattice vector quantization technique .The result found to be better and low distortion than vector quantization [2] [3].

Keywords*- Conditional Split Lattice Vector Quantization, Decoding, Image Processing, Compression, Encoding.*

1. Introduction

The fundamental goal of image compression is to obtain the best possible quality, for a given storage or communication capacity. There are many compression techniques available but still there exists a need to develop faster and more robust algorithm for image compression. To achieve high compression ratio while retaining fine details in image Discrete Wavelet Transform is considered in work. To save on computation, storage cost and transmission of different images a fixed decomposition structure is designed. To obtain high compression ratio we follow vector quantization. In this work we chose conditional split lattice vector quantization (CSLVQ) which gives the superior performance over the other types of vector quantization techniques [2][3].

The image compression using conditional split lattice vector quantization is lossy compression technique. This technique (CSLVQ) allows the splitting to lower dimensions. For different dimensions same quantization function can be used. The CSLVQ is composed of two parts, encoder and decoder. For the encoding part, take the input vector from the image matrix and then reshape it. After reshaping calculate the threshold energy. If threshold energy is greater than or equal to other energy then it will split into the lower dimension matrix. The same procedure is again applied for the lower dimension matrix for splitting.

The rest of paper is organized as follows. The lattice vector quantization is explained in section 2. Conditional split lattice vector quantization is discussed in section 3. Image decomposition and image quantization (CSLVQ) is briefly described in section 4 and 5. Flowchart of the image compression using CSLVQ is shown in section 6. Experimental results are discussed in Section 7, followed by conclusion in Section 8.

2. Lattice Vector Quantization

Let $\{u_1,u_2,\ldots u_n\}$ be a set of linearly independent vectors in R^n. Then lattice Λ generated by $\{u_1,u_2,\ldots,u_n\}$ is a set of all points of the form

$y=\sum c_i u_i$ ------------------------ [1]

where, i goes 1 to n & where c_i is integer.

The vectors $\{u_i\}$ is a basis for n dimensional lattice. The matrix $U=[u_1\ldots u_n]^T$ is a generator matrix of the lattice. Any vector of the lattice

$Y=c\,U$ ------------------------ [2]

Where $c=\{c_1,\ldots,c_n\}$.

Codebook can be obtained by selecting a finite number of lattice points out of an infinite lattice. Root lattice, a truncation and a scaling factor decided the LVQ codebook. The root lattice is the lattice set from which the codebook is actually constructed. A truncation must be applied on a root lattice in order to select a finite number of lattice points and quantize the input data with finite energy. The LVQ bit rate is dependent on the number of points in the truncated area. To obtain the best accommodation to the source probability distribution, the lattice must be scaled and truncated properly [4][5][6].

3. Conditionally Split Lattice Vector Quantization Technique

Vector quantizer method allowing the reduction of the complexity of the encoding process at the expense of coding performance. The conditional split lattice vector quantizer technique (CSLVQ) use a split quantizer when demanded by the input data. The high dimensional lattice is main quantizer. High dimensional lattice point matrix will split into two lower dimensional lattice points matrix. Suppose there are D values D = {d1;d2;d3;d4…..dD}, decreasingly splitting rules for each of them:

Energy $=E=\sum d^2$---------------------------- [3]

then the fixed particular energy value is the threshold value. If the energy is less than the selected energy then it will not split into lower dimension but when it is greater than or equal to the selected value then it splits into the lower dimensions.

4. Image Quantization using Conditional Split Lattice Vector Quantizer

The transformation coefficients are grouped according to the frequency values. For the transformation DWT is used. The DWT provides sufficient information for the analysis and synthesis of a signal but is advantageously, much more efficient. Discrete wavelets analysis is computed using the concept of filter banks. Filter of different cut off frequencies analyses the signal at different scales. Resolution is changed by filtering. The scale is changed by up sampling and down sampling.

If signal is passing through the high pass filter then,

(1) Only high frequency information is kept.

(2) Low frequency information is lost.

If signal is passing through the low pass filter then,

(1) Only low frequency information is kept.

(2) High frequency information is lost

After passing through filter, signal is effectively decomposed into two parts:

(1) Detailed part and

(2) Approximate part.

The sub signal produced from the low filter will have a highest frequencies equal to half that of the original. According to Nyquist sampling criterion, this change in frequencies range means that only half of the original samples need to be kept in order to perfectly reconstruct the signal.

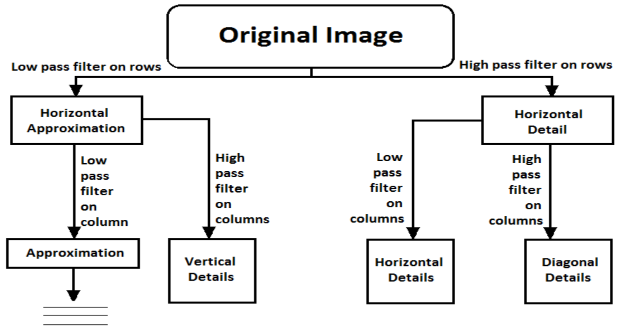


Figure 1: Flowchart of image filtering

After transformation the different coefficients of the image are obtained but maximum information of the image is carried by approximation component. Then the whole process conditional split lattice vector quantizer is applied on approximation coefficient

5. Splitting Rule

Four parts are generated after passing an image through filter. Viz. approximation, detail, vertical and horizontal. But encoding process is applied on approximation part first. The approximation part is normalized and then reshaped.

After reshaping, calculate the energy and decide a particular energy value and split into different dimensions. After normalization if image size 512 x 32 is split into 32=16+16, 16=8+8, 8=4+4, 4=2+2 [1].

For calculation of energy, first square each element of the matrix then add each element row wise.

After calculating energy, set threshold energy.

Threshold Energy= sum of energy /total no. of energy

Later decode it in exact reverse manner. Consider a following example of matrix

$$\begin{bmatrix} 1 & 0 & 1 & 2 & 3 & 1 & 1 & 0 \\ 1 & 0 & 1 & 2 & 1 & 0 & 1 & 2 \\ 3 & 0 & 0 & 1 & 0 & 1 & 1 & 4 \\ 1 & 2 & 1 & 0 & 1 & 0 & 1 & 2 \\ 1 & 0 & 1 & 0 & 1 & 0 & 2 & 3 \\ 1 & 2 & 2 & 0 & 1 & 0 & 1 & 1 \\ 2 & 1 & 0 & 0 & 2 & 0 & 0 & 1 \\ 2 & 2 & 2 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

Now calculate the energy from each row

$$\begin{bmatrix} 17 \\ 12 \\ 16 \\ 12 \\ 16 \\ 12 \\ 10 \\ 17 \end{bmatrix}$$

By the lattice property, each odd energy is converted into the even

$$\begin{bmatrix}18\\12\\16\\12\\16\\12\\10\\16\end{bmatrix}$$

Threshold Energy= (18+12+16+112+16+12+10+16)/8
Threshold Energy =14
Split into lower dimension if the energy ≥Threshold Energy

$$\begin{bmatrix}1&0&1&2\\3&0&0&1\\1&0&1&0\\2&2&2&1\end{bmatrix} \quad \begin{bmatrix}3&1&1&0\\0&1&1&4\\1&0&2&3\\1&1&1&1\end{bmatrix}$$

In this way split the higher matrix into the lower dimensional matrix.

6. Flow Chart

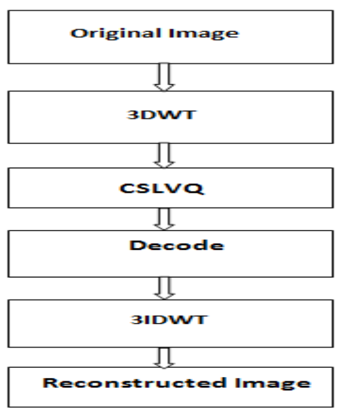


Figure 2: Flowchart of proposed algorithm

7. Experimental Result

PSNR is measure criterion for the compression, which can be calculated from original and reconstructed image.

1. MSE:-

$$MSE = \frac{1}{M}\sum_{I=1}^{M}\left(\hat{x}_i - x_i\right)^2 \text{ ----------------------[4]}$$

Where M is the of elements in the image
For calculation of MSE between the reconstructed and the original image, take the difference between the two images, pixel by pixel. Square the results, and average the results, as represent in above formula.

2. PSNR:-

$$PSNR = 10\log_{10}\left(\frac{\left(2^{n}-1\right)^{2}}{MSE}\right)$$ ----------------------[5]

Where n is the number of bits per symbol. For example, to find the PSNR between two 256 gray level images, set n to 8 bits [3].

Table 1. Result of CSLVQ for different images

Sr.No.	Original image	MSE	PSNR
1	Peppers	37.31	32.41
2	Cameraman	32.22	33.92
3	House	23.26	34.40

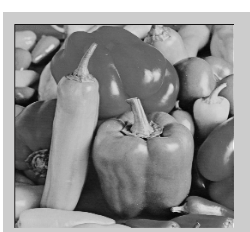
Table 2. Result of VQ for different images

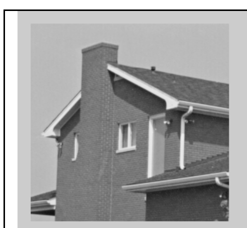
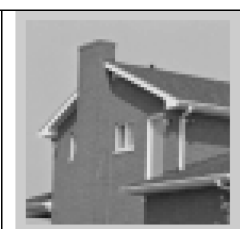
Sr. No.	Original Image	PSNR
1	Peppers	28.5
2	Cameraman	28.2
3	House	21.9

From the above table it is clear that the PSNR of the image is improved by using the conditional split lattice vector quantization method [2][3].

3
Figure 3: Peppers Image

4
Figure 4: House Image

	
Original Image	Compressed Image
MSE	37.31
PSNR	32.41

	
Original Image	Compressed Image
MSE	23.26
PSNR	34.40

	
Original Image	**Compress Image**
MSE	**33.22**
PSNR	**33.92**

Figure 5: Cameraman Image

8. Conclusion

In this paper the conditional split lattice vector quantization method is used and efficient and effective algorithm for image compression is developed. The result quality of reconstructed image is good as well as preservation of significant image details is achieved along with the high compression rates.This algorithm compresses the image very fast. After comparing the other methods of vector quantization, it is observed that proposed algorithm gives compression of images with improved Compression ratio and PSNR.

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