Implementation of Wavelet Packet Transform using Vector Quantization for RT video

Prof. P.R. Badadapure, Research Scholar, Dept. of Electronic and communication, JJTU, Rajasthan.

badadapurep@gmail.com

Abstract- The purpose of this paper is to introduce an image compression scheme using a combination of wavelet packet transform and vector quantization. All the wavelet packet bases corresponding to various tree structures have been considered and the best one has been coined based upon the peak signal to noise ratio and compression ratio of the reconstructed image. In first step input image decorrelation using the wavelet packet transform, the second step in the coder construction is the design of a vector quantizer. Vector Quantization (VQ) is fast and efficient method of quantizing Laplacian-like data, such as generated by transforms (especially wavelet transforms) or sub-band filters in an image compression system. VQ has very simple systematic encoding and decoding algorithms and does not require codebook storage. VQ has culminated in high performance and faster VQ image compression systems for both transforms and subband decompositions.

The proposed algorithm provides a good compression performance The introduction of wavelets gave a different dimension to the compression. But there are some limitations of wavelets while handling the line and curve singularities in the image. There are transforms beyond wavelets namely – Curvelet and Ridgelet Transforms. This paper aims at the analysis of compression using Curvelet, Wavelet and the Ridgelet Transform. The Curvelet Transform gives better performance in terms of PSNR. Wavelet performs the least and is also affected by the blocking artifacts. By selecting proper thresholding method, better results for PSNR have been obtained.

Using the proposed algorithm the compression ratio is increased by about 25 – 30 % as compared to conventional DWT technique.

Index terms- Wavelet Packets transform, Vector Quantization, Curvelet Transform, Ridgelet Transform, Discrete Wavelet Transform, Quadrature Mirror Filters.

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1 Introduction

Most existing high performance image coders in application are transform based coders, and this exists for a very good reason: the transform coder provides good compression performance with reasonable complexity. In the transform coder, the image pixels are converted from the space domain to the transform domain through a linear orthogonal or bi-orthogonal transform. The transform decorrelates the pixels and compacts their energy into a small number of coefficients, results in efficient coding of the transform coefficients. Since most of the energy is compacted into a few large transform coefficients, we may adopt entropy coding scheme that easily locates those coefficients and encodes them. Because the transform coefficients are decorrelated, the subsequent quantizer and entropy coder can ignore the correlation among the transform coefficients, and model them as independent random variables. [1]

The optimal transform of an image block can be derived through Karhunen-Loeve (K-L) decomposition. However, the K-L transform lacks fast computation, and the transform is content dependent. It is thus not suited for the compression purposes. Popular transforms used in image coding include block based transform, such as DCT, and wavelet transform. DCT transform of the image block can be quickly computed. It achieves very good energy compaction and coefficient decorrelation. The widely used

image compression standard JPEG is a DCT based coding algorithm. However, the DCT is calculated on block of pixels independently, therefore, coding error causes discontinuity between the blocks which leads to annoying blocking artifact [2]. On the contrary, the wavelet transform operates on the entire image, (or a tile of a component in the case of large color image). It offers better energy compaction than the DCT, and no blocking artifact after coding. The resultant wavelet coefficient can be easily scaled in resolution: by not using the wavelet coefficients at the finest M-levels, we may reconstruct an image that is 2^M times smaller than the original one. The multi-resolution capability of the wavelet transform lends it ideally to scalable image coding. [3]

2 Discrete Wavelet Transform (DWT)

Wavelets have recently emerged as a powerful tool for image compression. The discrete wavelet transform maps an image into a set of coefficients that constitute a multiscale representation of the image. Discrete Wavelet Transform (DWT) of a signal $x(n)$ is computed by passing it through a series of filters. First the samples are passed through a low pass filter with impulse response $g(n)$ giving approximation coefficients. The signal is decomposed simultaneously using a high pass filter $h(n)$, giving the detailed coefficients. The low pass filter gives

approximation coefficients. These filters are called quadrature mirror filters (QMF). Since half the frequencies of the signal are removed, the filter outputs are down sampled by 2. [5]

$$Y_{high}[k] = \sum_n x[n].g[2k-n] \dots\dots\dots Low\ Pass\ Filter$$

$$(1)$$

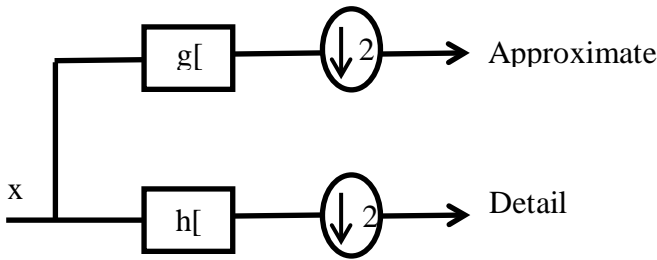$$Y_{low}[k] = \sum_n x[n].h[2k-n] \dots\dots\dots High\ Pass\ Filter$$

fig1. One Level Decompositions

3   Proposed Methodology:

➢ **Step 1:** Call the .dat files & read the original image.

➢ **Step 2:** Use the formulas to calculate smooth and detail coefficients for the given image.

$$a_{j,n} = \sum_k h(2n-k)a_{j-1,k} \qquad (2)$$

$$d_{j,n} = \sum_k g(2n-k)a_{j-1,k} \qquad (3)$$

Where $a_{j,n}$ = Smooth Coefficients

$d_{j,n}$ = Detail Coefficients

➢ **Step 3:** Generate the .dat file of the results.

➢ **Step 4:** Extract the value of transformed signal.

➢ **Step 5:** The input image is decomposed using wavelet and quantized with a variable *multiplier* value. The thresholding is done on the mean value of the respective subbands. Assume that subband is *s(i, j)*.

$$v = \left(\frac{1}{n}\right)\sum_{i,j}|s(i,j)| \qquad (4)$$

Where n= i*j

➢ **Step 6:** The wavelet coefficients above the threshold value will be retained and others will become zero.

➢ **Step 7:** The image is reconstructed by the formula given below:

$$a_{j-1,n} = \sum_k h(n-2k)a_{j,k} + \sum_k g(n-2k)a_{j,k}$$
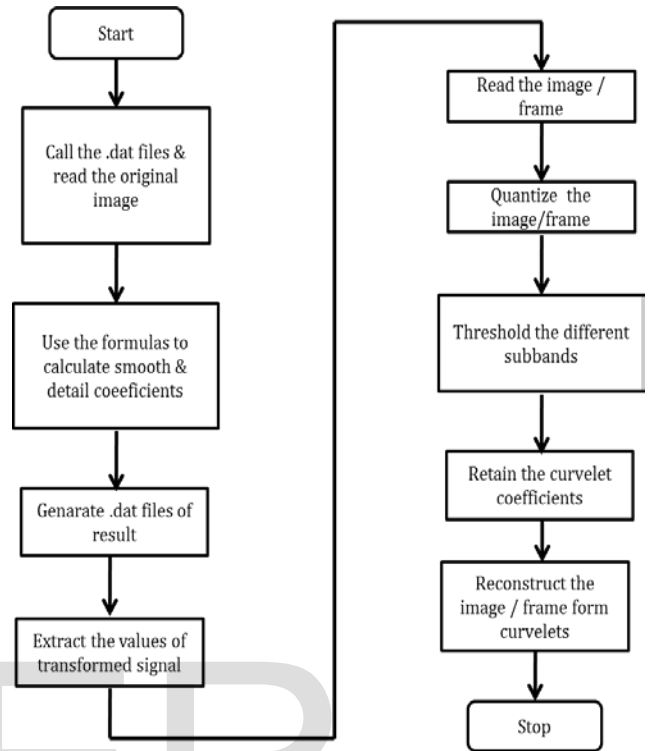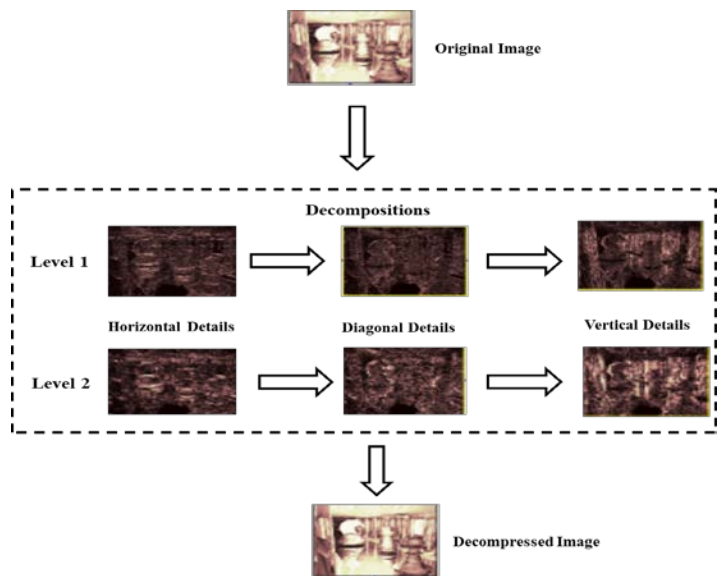
$$(5)$$

Where h = scale function
g = Wavelet function

fig2. Flow chart for proposed algorithm
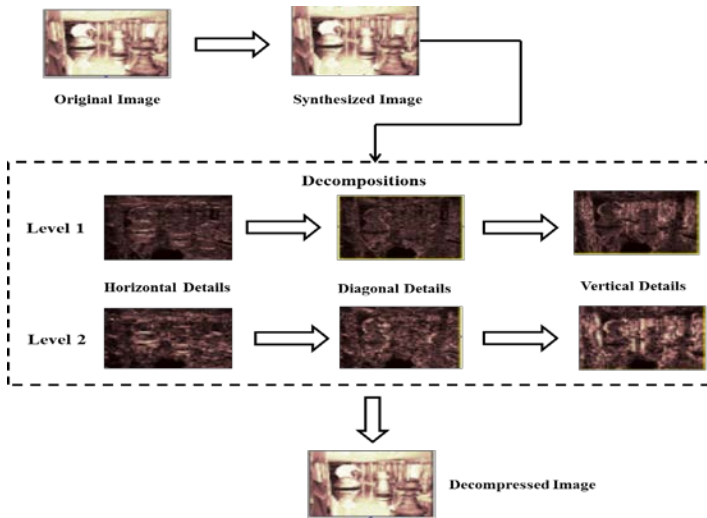
4   Results

A) Conventional DWT:

Compression Ratio Achieved: 57.05 %
fig3. Conventional DWT output

B) Proposed Algorithm:

Compression Ratio Achieved: 85.45 %

Fig. 4 Proposed DWT output

5 Conclusion

The image compression technique based on wavelet packet transform is found to perform well with compression ratio and good PSNR values. The results demonstrate significant increase in compression ratio using wavelet packet with good signal to noise ratio for standard as well as high frequency images.

Using the proposed algorithm the compression ratio is increased by about 25 – 30 % as compared to conventional DWT technique.

6 References

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