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# Image Transmission using LDPC with Stationary Wavelet Transform

[1] Priyanka Chavan [2] Chitra M.
[1]PG Student [2] Associate Professor
[1][2]Department of Electronics and Communication
M. S. Ramaiah Institute of Technology Bangalore, India
[1]priyankabc29@gmail.com [2]chitra.m@msrit.edu

***Abstract*— The two approaches to represent some data are videos and images. Image compression is a method through which we can increase the storage capacity for images and videos and increases transmission process's performance. During transmission of data disturbances present on the transmission channel may degrade the performance, therefore we use channel coding such as turbo coding and LDPC coding which ensure transmission with minimum errors on transmission channel. Some of the application such as for mobile and space communication uses these coding techniques. In this paper we are using few transform technique. Discrete cosine transform (DCT), stationary wavelet transform (SWT) and discrete wavelet transform (DWT) with channel coding technique, low density parity check (LDPC) code has been used.**

***Keywords*— DCT (Discrete Cosine Transform), DWT (Discrete Wavelet Transform), SWT (Stationary Wavelet Transform), LDPC (Low Density Parity Check Code)**

## I. INTRODUCTION

Now a days due to increase in demand of multimedia communication such as satellite network, terrestrial broadcast network and accessing of data through internet, image compression has become necessary for efficient transmission. Uncompressed data needs large capacity to store images and large transmission bandwidth so it important to compress the image and the space or memory required to store the image is less. Therefore we are using three compression techniques DCT, SWT, and DWT for compressing the image. Due to noise present in the channel, data at the output of a communication channel will be corrupted these errors can be reduced by channel coding techniques. Coding reduces error and increases transmission rate at a fixed error rate. A way to protect the message from errors is called channel coding. The coding can help to retrieve the data even when noise is present. LDPC gives better result compared to other coding techniques.

## II. TRANSFORM CODING

### a. *Discrete Cosine Transform*

The discrete cosine transform is a transform matrix of size N x N and the values of the matrix are function of cosine terms. It is a frequency based technique and converts each pixel in an image into set of spatial frequencies. DCT is a modified version of DFT which uses both imaginary and real data for computation and hence computation is complex. Whereas, DCT uses only real data to compute its coefficients which reduces no. of computation. Form 2N point sequence of DFT is reduced to N point sequence of DCT. The DCT values are periodic and symmetric. For an image, image is divided into NxN block and then dct coefficients are calculated for each block and these coefficients are quantized and inverse dct is performed.

The definition of the two-dimensional DCT for an input image P and output image Q is

$$B_{mn} = \alpha_m \alpha_n \sum_{p=0}^{P-1} \sum_{q=0}^{Q-1} A_{pq} \cos\frac{\pi(2p+1)m}{2P} \cos\frac{\pi(2q+1)n}{2P},$$

$$0 \le m \le P-1; 0 \le n \le Q-1 \qquad (1)$$

IDCT

$$A_{pq} = \sum_{n=0}^{Q-1} \alpha_m \alpha_n B_{mn} \cos\frac{\pi(2p+1)M}{2P} \cos\frac{\pi(2q+1)N}{2P},$$

$$0 \le p \le P-1; 0 \le q \le Q-1$$

Where

$$\alpha_m = \begin{cases} \frac{1}{\sqrt{P}}, & m = 0 \\ \sqrt{\frac{2}{P}}, & 1 \le M \le P-1 \end{cases}$$

And

$$\alpha_n = \begin{cases} \frac{1}{\sqrt{Q}}, & n = 0 \\ \sqrt{\frac{2}{Q}}, & 1 \le n \le Q-1 \end{cases}$$

P and Q are the row and column size of A, respectively. The DCT coefficient of a real data is also real. The DCT concentrates on information and makes it useful for image compression.

**PROCESS:**

1. The Real image is divided into cubes of 8 x 8 or 16 X 16 blocks of pixels.
2. For gray scale image pixel value ranges from 1-256 therefore DCT has pixel values ranging from -128 to 127.
3. 2-D DCT is applied on each block. Equation (1) is used to calculate DCT coefficients.
4. Quantization is applied on DCT coefficients and coding and transmission of coefficients is done.
5. At the receiving end decoding of coefficient is done compacted image is reconstructed
6. Reverse DCT (IDCT) is performed [5].

### *b. Discrete Wavelet Transform*

Wavelet transform make use of the special correlation and frequency correlation. Wavelet compression is alike sub band coding where signal is disintegrated by filter banks. After the wavelet transform image is broken down into approx. and detailed sub signals. The approximation sub signal contains maximum pixel values and other three sub signals contain horizontal, diagonal and vertical detail. These three sub band signals can be set to zero if its values are below threshold value and hence increases compression ratio [1].

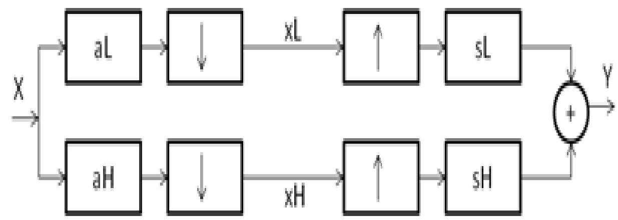



***Fig1.Two channel filter bank for DWT***

Where

aH- high pass filter; aL-low pass filter for input sequence
sH- HP filter; sL-LP filter for reconstructed signal
xH and xL – transform signal

For 2D image we will have four filter banks, one is for approximated coefficients and other three for horizontal, vertical and diagonal detail coefficients.

The DWT for a 2D signal such as image can be obtained from 1D DWT. By multiplying two 1D functions we can obtain low pass and high pass signal for 2D signal. For each row pixel values of a 2D image, 1D wavelet transform is applied to obtain an intermediate values along with coefficients for each row and 1D transform is applied to each column. For 2D image there will be 3 wavelet functions that read pixel values in vertical, horizontal and diagonal direction. To represent this four filter banks are used [2].

In DWT we have four types of wavelets:

1. Haar wavelet transform

2. Biorthogonal wavelet transform

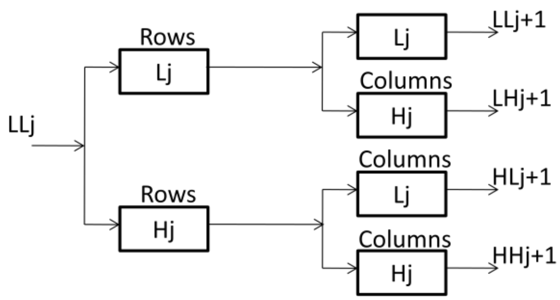
3. Daubechies Wavelet transform

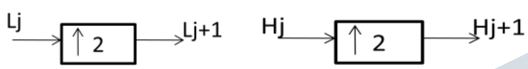
4. Symlet wavelet transform

### *c. Stationary Wavelet Transform*

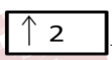
The stationary wavelet transform is an extended version of standard DWT. In DWT rendered version of a signal x is not the similar to the DWT of the original signal. To overcome this translation invariance of DWT we go for SWT.
DWT uses up sampler and down sampler for its operation, after down sampling of filter coefficients, the threshold and decomposed coefficients may result in infirm and edge distortion . In SWT at each level of data low and high pass

filters are applied to produce two sequences at next stage. The lengths of the two new sequences are same that is, have same number of sample in input and output. Every filter is modified at each stage just by filling out the space with zeros [3].




Where



Up sample

*Fig 2.Two dimensional SWT*

## III. LOW DENSITY PARITY CHECK MATRIX

LDPC was proposed by Gallager in his doctorate thesis at M.I.T. in 1960. The better and efficient performance of LDPC, these codes is widely used in today modern communication system. LDPC is capable of accomplishing a significant fraction of channel capacity at low complexity.

LDPC uses sparse check matrix which is generated randomly which has only a few 1's in that is compared with the amount of 0's.

LDPC code can be presented by Tanner graph which comprises of two vertices, 'n' vertices called bit nodes (for codeword bits) and m vertices called check node or variable nodes (for parity check equations). A v_node is connected to a c_node if that bit is present in the accompanying parity check equation so the number of connections in the Tanner graph is as same as the no. of ones in the parity-check matrix [4]. Considering a parity check matrix (H) n, k (8, 4).

$$H = \begin{bmatrix} 0 & 1 & 0 & 1 & 1 & 0 & 0 & 1 \\ 1 & 1 & 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 & 1 & 0 & 1 & 0 \end{bmatrix}$$

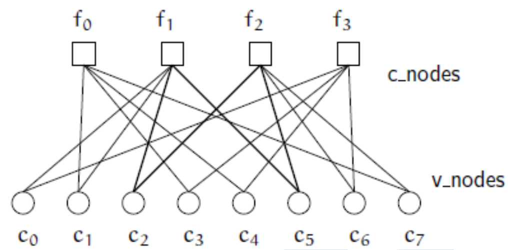



***Fig3 .Tanner graph representation to the parity check matrix H.***

C_node Fi is connected to v_node Cj if the element Hij of H is a 1.

## IV. EXPERIMENT RESULT

The experiment result when transform coding (DCT, DWT, and SWT) and error control coding (LDPC) Applied on an image.

The compression ration and PSNR is tabulated below

***Table1. Comparison result***

| Transform | Compression Ratio | PSNR |
|---|---|---|
| DCT | 1.05 | 6.043 |
| DWT | 2.33 | 11.916 |
| SWT | 3.07 | 12.117 |

The results are also included for images.

***Fig4. Input image***

***Fig5. DCT image***

***Fig6. DWT image***

***Fig7. SWT image***

## V. CONCLUSION

In this paper we did analysis of compression ratio and PSNR for three transform coding techniques that is discrete cosine transform, discrete wavelet transform and stationary wavelet transform with error control coding (LDPC). From Table1 we can say that SWT gives better compression ratio and better psnr compared to DCT and DWT. And from fig 5, fig 6, fig 7 we can see that SWT gives better quality image or clear image. Hence we can say that SWT is better than DCT and DWT.

### *Acknowledgement*

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