ENERGYEFFICIENT TRANSMISSION OF DWT IMAGE OVER OFDM USING BPSK, QPSK AND 16PSK

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***Abstract*:Orthogonal Frequency Division Multiplexing (OFDM) is a technique, in which a single high rate data-stream is divided into multiple low rate data-streams which is modulated using sub-carriers, which are orthogonal to each other.**

In this paper, an image is compressed using DWT, and the compressed data is arranged in four sub bands. These are then packetized and serially mapped to the OFDM system. After receiving the channels at the receiver the bad channel is dropped at the receiver side. MATLAB simulation has been analysed to check the performance of our proposed scheme, for quality of image and energy saving and comparison is done for BPSK, QPSK and 16PSK Modulations

Keywords: **OFDM, DWT, BPSK, QPSK, 16PSK.**

I INTRODUCTION

ORTHOGONAL Frequency Division Multiplexing (OFDM), also called as Discrete Multi-Tone (DMT), is a modulation scheme widely used in wired systems and wireless standards. [1]While OFDM is generally suited to handle ISI by frequency domain transmission and by using the Inverse Discrete Fourier Transform (IDFT)/Discrete Fourier Transform (DFT) and cyclic prefix insertion.[2] The idea behind the implementation of OFDM can be extended to the digital domain by using the discrete Fourier Transform (DFT) and its inverse, the inverse discrete Fourier Transform (IDFT).[3]These mathematical operations are widely used for transforming data between the time-domain and frequency-domain. These transforms are interesting from the OFDM perspective because they can be used to map the data onto subcarriers which are orthogonal to each other. For example, the IDFT is used to take in frequency-domain data and transform into it to time-domain data. In order to perform that operation, the IDFT correlates the frequency-domain input data with its orthogonal functions, which are sinusoids at particular frequencies. This correlation is equivalent to mapping the input data onto the sinusoidal basis functions. In practice, OFDM systems are implemented using a combination of fast Fourier Transform (FFT)[1] and inverse fast Fourier Transform (IFFT) blocks that are mathematically equal versions of the DFT and IDFT, respectively, but more efficient to implement. An OFDM system treats the source symbols at the transmitter as though they are in the frequency-domain. These symbols are given as the inputs to an IFFT block that converts the frequency domain signal into the time domain signal. [3]The IFFT takes in N symbols at a time where N is the number of subcarriers in the system. Each of these N input symbols has a symbol period of T seconds. Recall that the basic functions for an IFFT are N orthogonal sinusoids. These sinusoids each have a different frequency. Each input symbol acts like a complex weight for the corresponding sinusoidal basis function

Since the input symbols are complex, the value of the symbol determines both the amplitude and phase of the sinusoid signal for each subcarrier. The IFFT output is the summation of all N sinusoids. Thus, the IFFT block provides a easy way to modulate data onto N orthogonal subcarriers. The block of N output samples from the IFFT will together form a single OFDM symbol. The length of the OFDM symbol is NT where T is the IFFT input symbol period. After some additional processing, the time-domain signal which ias the output of IFFT is transmitted across the channel. At the receiver, an inverse of IFFT i.eFFT block is used to process the received signal and convert it into the frequency domain. Ideally, the FFT output will be the original symbols that were given to the IFFT at the transmitter.

The paper is organized as follows. Section II says about the system model, Section III describes about different modulations used in the project IFFT and

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Cyclic Prefix,, Section IV is about formulation and analysis.

II System Model

In our system model, an image frame is compressed using DWT, and the compressed data is arranged in four sub bands.[4]These four sub bands are then packetized and serially mapped to the OFDM system. the data transmitted through deeply faded channels are highly prone to error are to be discarded at the receiver side. Below, we described the DWTOFDM system model in details

A.DWT-OFDM system:

The proposed model is for transmission of DWT compressed data over OFDM channels in fading environment and illustrated. The steps involved are as follows:

1. DWT is applied on an image frame of original size S1×S2 pixels, producing four sub-images: HL, LH, HH, and LL, each of the size $\frac{S1}{2} \times \frac{S2}{2}$ pixels
2. From these sub-images four coefficient vectors are generated, each of length$\frac{S1-S2}{2}$.
3. These sub-images are packetized and serially mapped on to OFDM system.

attemptscan be eradicated based on the Nyquist's rule, as the signal now has the top frequency of π/2 radians rather than of π. The signal can consequently be subsampled by 2, merely by neglect every second sample. This comprises one level of decomposition and can arithmetically be stated as follows:

$yhigh[k] = \Sigma x[k]g[2k–n]$ (1)

$ylow[k]= \Sigma x[k]h[2k-n]$ (2)Where $yhigh,k$- and $ylow,k$- are the yields of the highpass and low pass filters, correspondingly, following the subsampling by 2. The above mentioned process can be continual for additional decomposition. The yields of the high pass and low pass filters are named as DWT coefficients. The original image can be reconstructed utilizing this IDWT. The reconstructed method is known as the Inverse Discrete Wavelet Transform (IDWT). The signals at every level are passed through the synthesis filters g' [n], and h' [n], and then added. The synthesis and analysis

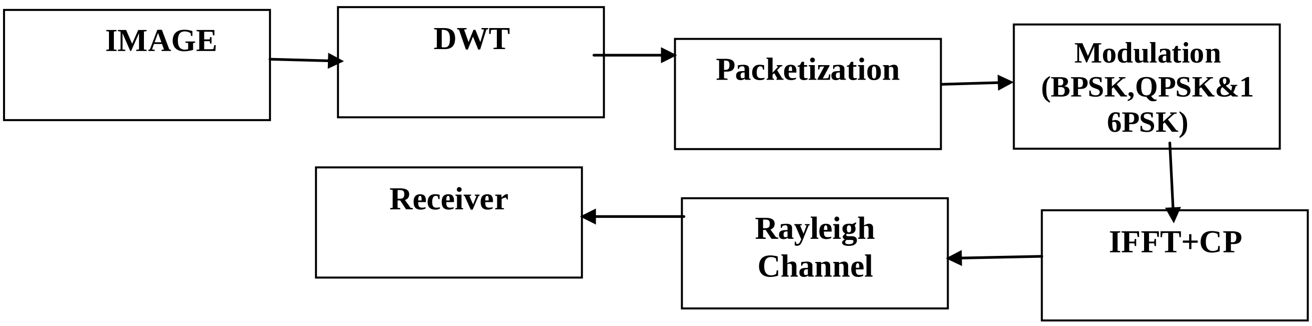

Fig.1 DWT OFDM system

B. Discrete Wavelet Transform (DWT): The fundamental concept of DWT for one dimensional signals is briefly explained as fallows. A signal is partitioned into two parts, one is the low frequency part and other is high frequency part. This partitioning is called as decomposition. The edge aspects of the signal are generally enclosed to the high frequencies part. The signal is passed down through a large number of high pass filters to calculate the high frequencies, and then handed down through a number of low pass filters to evaluate the low frequencies. Filters with cut-off frequencies are used to examine the signal at different resolutions. Let's assume that x[n] is the initial signal, having a frequency band of 0 to π rad/s. The signal x[n] is initially passed through a half band high pass filter g[n] and a low pass filter h[n]. Following the filtering, half of the

filters are alike to each other, except for a time reversal. So, the reconstruction formula becomes

$[n] = \sum yhigh[k]g[2k–n]+ylow[k]h[2k –n]$ (4)

The DWT and IDWT for a one-dimensional signal can be shown in the form of two channel tree structured filter banks. The DWT and IDWT for a two-dimensional image x [m, n] can be similarly defined by implementing DWT and IDWT for each dimension m and n separately $[[x][mn]]$.

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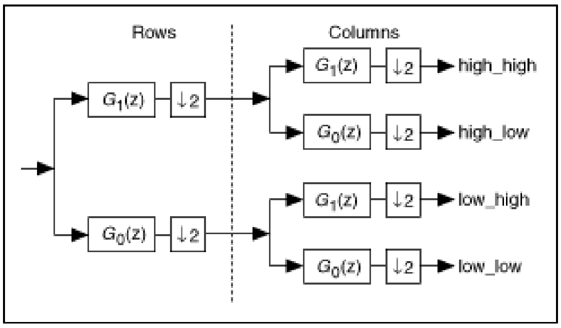

Fig.2 DWT for two-dimensional images

An image can be decomposed into a pyramidal structure, which is shown in Figure 4, with various band information: low-low frequency band LL, low-high frequency band LH, high-low frequency band HL, high frequency band HH.

LL	LH
HL	HH

Fig.3 Pyramidal structure

IIIMODULATION

BPSK: The BPSK modulation is technique is simplest and most robust of all psk modulation techniques since it takes the highest level of noise or distortion to make the demodulator reach an incorrect decision. It is, however only able to modulate at 1bit/symbol and so is unsuitable for high data rate application. BPSK is a modulation technique in which the phase of carrier signal is varied according to modulating signal.

$$s_n\,(t) = \sqrt{\frac{E_s}{T_s}}\cos(2\pi f_c t + (1-n)\pi) \quad (5)$$

where f_c is the frequency of the carrier-wave.

QPSK: The modulation scheme is very important for developing concepts of two dimensional .In a sense ,QPSK is an expanded version from binary PSK where in a symbol consists of two bits and two orthogonal basis function are used. A group of two bits is called is ‘debit’ .So 4 bits are possible.

$$s_n\,(t) = \sqrt{\frac{E_s}{T_s}}\cos\left(2\pi f_c t + (2n-1)\frac{\pi}{4}\right) \quad (6)$$

16PSK: In 16PSK where in a symbol consists of four bits i.e. it can transmit four bits at a time and phase shift between two phases is 22.5

Table.1 Transmission of bits/symbol

MODULATION	Bits/Symbol	Symbol rate
BPSK	2	½(0.5)
QPSK	4	¼(0.25)
16PSK	16	1/16(0.0625)

IFFT: The IFFT transform a spectrum (amplitude and phase of each component) into a time domain signal. An IFFT converts a number of complex data points, of length that is power of 2, into the same number of points in time domain. Each data point in frequency spectrum used for an FFT or IFFT operation is called a bin.

Cyclic prefix:
A cyclic prefix is a repetition of the first section of a symbol that is appended to the end of the symbol

Receiver: The receiver basically does the reverse operation to the transmitter. The guard period is removed. The FFT of each symbol is then taken to find the original transmitted spectrum. The phase angle of each transmission carrier is then evaluated and converted back to the data word by demodulating the received phase. The data words are then combined back to the same word size as the original data

IV FORMULATION AND ANALYSIS

The performance of the proposed scheme depends on probability of the loss events.
For Rayleigh fading channel, the received power Pr is exponentially distributed with probability density function (pdf) given by:

$$fp = \frac{1}{p}\exp(-\frac{a}{p}) (7)$$

where p be the average received power. If F is the fading margin, it is related to the receiver threshold sensitivity Pth as:

$$F = \frac{p}{Pth} \quad (8)$$

Where Pth is varied from 6 to15
Let P be the probability that a sub-band is in deep fade. P can be expressed as:

$$P = 1 - \exp(-\frac{1}{F}) \quad (9)$$

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Let Pi = probability associated with the loss event i, for i =0 ,1,2,3,4.Thus, for an arbitrary received packet we can write:

$$Pi = \binom{4}{i} P^{4-i}(1-P)^{i} \qquad (10)$$

Energy saving measure:
In the proposed scheme the less important data vectors are dropped at the receiver to save power if corresponding subchannel is in fading state.
Measure of the percentage of energy saving, we can write energy saving expression as:

$$\%energy\ saved = 100X \sum_{i=0}^{4} iPi/4 \quad (11)$$

VRESULT&DISCUSSION

For simulations we transmitted standard Lena image of size 256 × 256 pixels. At here we have taken OFDM system with IFFT size of 256 and carrier size of 64 by these 32 packets are transmitted in simulation process .This packets are distributed in frequency domain and time domain. The packets are transmitted back to back; data will be corrupted due to time delay in process. So, we had given time interval for each packet while transmitting through subcarriers.

We simulated block fading channel with number of sub-bands 4.The results shown are of QPSK modulation.

The Fig.5 shows PSNR's of 4 sub channels. We can observe the PSNR variation according to the importance of the data vectors.

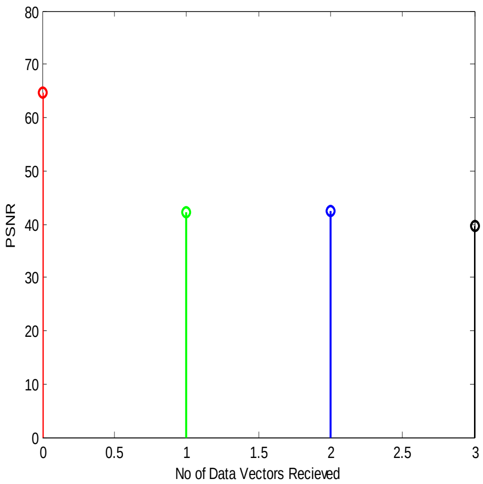

Fig.4 PSNR of 4sub channels

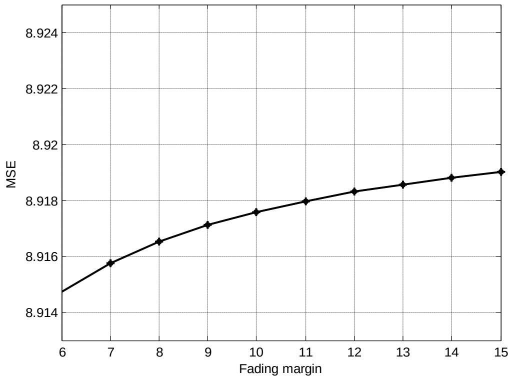

Fig.5Simulation results for distortion

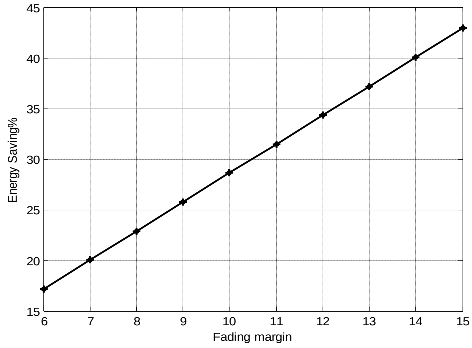

Fig.6 Simulation results for % energy saved

Analytically obtained percentage of energy saving, given by (11), are plotted against the Pth in Fig. 6, where the analyzed results are supported by simulated values. Fig. 5, it can be concluded that the distortion in reception process increases with power threshold Pth.

It follows from the figure that the energy saving is also increasing by dropping bad channel at the receiver.

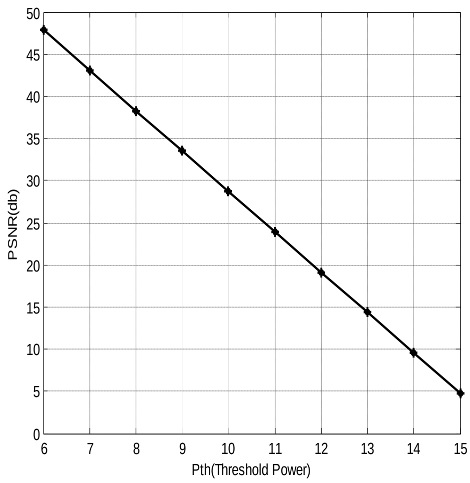

Fig.7 Simulation results for PSNR of received

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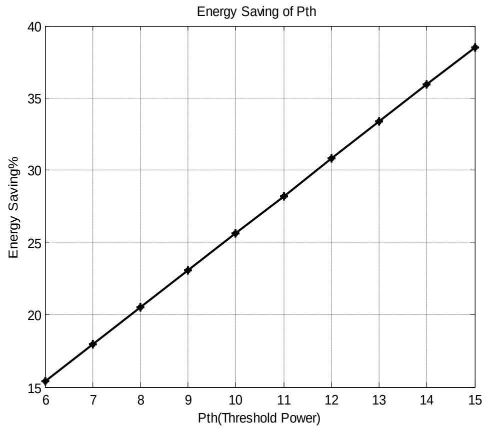

Fig.8 Simulation results for % energy saved

Transmission of Lena image through the OFDM system provides simulation data, showing PSNR and energy saving variations (quality) in Fig. 7and Fig. 8

Table:2comparisons of modulations for SNR=15

SNR=15	BPSK	QPSK	16PSK
PSNR	53.68	51.44	47.70
Energy saving	37.16	38.49	41.09

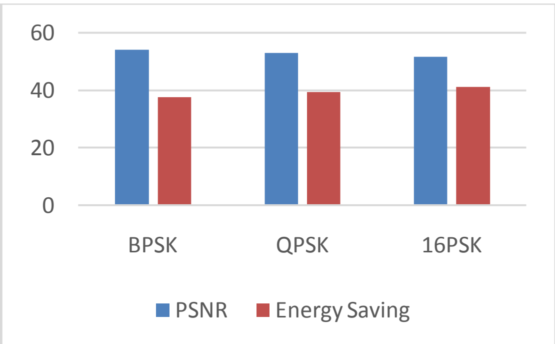

Fig.9 comparisons of modulations for SNR=15

Table:3 comparisons of modulations for SNR=40

SNR=40	BPSK	QPSK	16PSK
PSNR	54.25	53.0019	51.79
Energy Saving	37.71	39.4	41.27

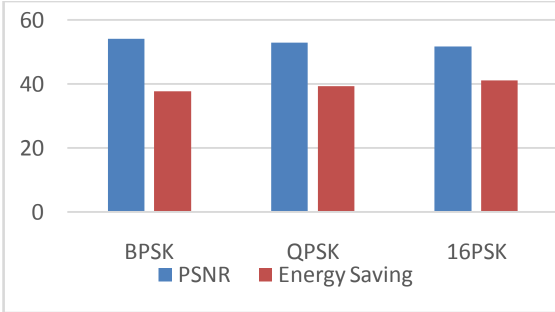

Fig.10 comparisons of modulations for SNR=40

VI CONCLUSION

Image transmission through OFDM provides high data rate transfer but there is lot of energy consumption. This project presents an energy saving approach to transmission of discrete wavelet transformation based compressed image frames over the OFDM channels. The proposed method drops the bad channel at the receiver and energy is calculated for received image and comparison is done for BPSK,QPSK and 16PSK modulations and 16PSK provides high energy saving compared to BPSK and QPSK i.e 41% of energy saving

VIIREFERENCES

[1] Noura Al-Hinai, Katrina Neville, Amin Z. Sadik, MIEEE, and Zahir M. Hussain, SMIEEE "Compressed Image Transmission over FFT-OFDM: A Comparative Study" 2007 Australasian Telecommunication Networks and Applications Conference

[2] Ye (Geoffrey) Li, Senior Member, IEEE "Pilot-Symbol-Aided Channel Estimation for OFDM in Wireless Systems" IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, VOL. 49, NO. 4, JULY 2000

[3] S .Weinstein and P. Ebert, ―Data Transmission by Frequency Division Multiplexing Using the Discrete Fourier Transform,‖ IEEE Transaction on Communication, Vol.19, and Issue: 5, pp. 628–634, Oct.1971

[4] "Performance Analysis of OFDM System under FFT, DWT and DCT Based Transform Techniques" Anshul Soni1, Ashok Chandra Tiwari

[5] Mohamed E. Khedr, Member IEEE, Moustafa H. Aly, Member OSA and Mohamed E. Tamazin "Optical Orthogonal Frequency Division Multiplexing For High Speed Wireless Optical Communications" 978-1-4244-1980-7/08/$25.00 ©2008 IEEE

[6] Rafael C. GONZALEZ Richard E. WOODS. Digital image processing: seconded [M]. Beijing Publishing House of Electronics Industry 2002。

[7] R.S. Youail, A.-K.A.-R. Khadhim, and V.W. Samawi. "Improved stegosystem using DFT with combined error correction and spread spectrum." in 2nd IEEE ICIEA, 2007. pp. 18321836

ISSN: 2278 – 1323

[8] A. R. Calderbank, 1. Daubechies, W. Sweldens and B. Yeo., "Wavelet transforms that map integers to integers". Applied and Computational Harmonic Analysis, vol.5, noJ, pp.332-369, 1998.

[9] B.R. Satzberg, "Performance of an Efficient Parallel Data Transmission System," IEEE Trans. Commun. Technol., Vol.COM-15, no.6, pp. 805-811, Dec 1967.

[10] R.W Chang, "Orthogonal Frequency Division Multiplexing," U.S Patent 3388455, Jan 6, 1970, Filed Nov.4.1966

[11] Kiani, A.; Baghersalimi, G.; Zanj, B., "Performance assessment of DFTOFDM and DWT-OFDM systems in the presence of the HPA nonlinearity," Telecommunications (ConTEL), Proceedings of the 2011 11th International Conference on, vol., no., pp.273, 278, 15-17 June 2011

[12] M. K. Lakshmanan and H. Nikookar, "A review of wavelets for digital wireless communication," Journal on Wireless Personal Communication, vol. 37, no.3-4, pp. 387-420, Springer, May 2006.

[13] R. Knopp and P. A. Humblet, "On coding for block fading channels," IEEE Trans. info. Theory, vol. 46, no. 1, pp. 189–205, Jan. 2000.

[14]Lakshmi PujithaDachuri, NaliniUppala "Energy Efficient Transmission of Image over DWT-OFDM System" International Journal of Electrical, Computer, Electronics and Communication Engineering Vol:7, No:9, 2013

[15] Y. Li and G. L. Stueber, Orthogonal frequency division multiplexing for Wireless Communications, Springer, 2005.

[16] C. Christopoulos, A. Skodras, and T. Ebrahimi, "The JPEG2000 still image coding system: An overview," IEEE Trans. Consumer Electron, vol. 46, no. 4, pp. 1103–127, Nov. 2000

[17] J. Armstrong, ―Analysis of new and existing methods of reducing inter carrier interference due to carrier frequency offset in OFDM,‖ IEEE Trans. Commun., vol. 47, No. 3, pp. 365–369, Mar. 1999.

[18] Y. S. Chan, P. C. Cosman, and L. B. Milstein, "A cross-layer diversity technique for multi-carrier OFDM multimedia networks," IEEE Trans. Image Proc., vol. 15, no. 4, pp. 833–847, Apr. 2006.

[19] Marc ANTONINI Michel BARLAUD Pierre MATHIEU et al. Image coding using wavelet transform [J]. IEEE Trans. Image Processing 1992 1(2) 205-220。

[20] J. M. SHAPIRO. Embedded image coding using zero trees of wavelets coefficients [J]. IEEE Trans. Signal Processing 1993 41(12) 3445-346 2.

[21] Sharma, A.; De, S.; Gupta, H.M., "Energy-efficient transmission of DWT image over OFDM fading channel," Communication Systems and Networks (COMSNETS),2011 Third International Conference on , vol., no., pp.1,7, 4-8 Jan. 2011.

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