Performance Improvement Of DWT Image Transmission Over OFDM Fading Channel

Ms.G.Komala Yadav [1]
Electronics& Communication Engineering
Sreevidyanikethan Engineering College
Tirupathi; India

Ms.V. Mounika Reddy[3]
Electronics& Communication Engineering
Sreevidyanikethan Engineering College
Tirupathi; India

Mr.T.Krishna moorthy[2]
Electronics& Communication Engineering
Sreevidyanikethan Engineering College
Tirupathi; India

Abstract---In Many applications retransmission of lost packets are not permitted. In an OFDM system, If the channel state information is available at the transmitter, it is possible to take a proactive decision of mapping the descriptions optimally onto the good subcarriers and discard at the transmitter itself the remaining descriptions, which would have been otherwise dropped at the receiver due to unacceptably high channel errors. We proposed a model based approach which is energy efficient for the transmission of discrete wavelet transformation based compressed image frames over the OFDM channels. In order to reduce the system power consumption, we are transmitting only important data and we are reconstructing the image at the receiver side. Via analysis, supported by MATLAB simulations, we demonstrate the usefulness of our proposed scheme in terms of system energy saving without compromising the received quality in terms of peak signal-noise ratio.

Keywords— OFDM, DWT image, PSNR, IIFT, ISI

I. INTRODUCTION

It is always desired to increase the data rate over wireless channels. But high rate data communication is significantly limited by Inter Symbol Interference (ISI), Multi-carrier modulation is used for such channels to mitigate the effect of ISI[1][2]. The proposed method DWT-OFDM is used for fast data transmission and as an energy saving approach

OFDM is a multi-carrier modulation scheme having excellent performance which allows overlapping in frequency domain[3][4]. OFDM system provides an opportunity to exploit the diversity in frequency domain by providing a number of subcarriers, which can work as multiple channels for applications having multiple bit streams.

The purpose of this paper is to perform simulation study on the wavelet based OFDM particularly in DWT-OFDM as alternative substitution for Fourier based OFDM[5]. The study also includes zero padding and vector transposing for transmitting DWT-OFDM signal. By zero padding the signals, the transmitted signal is up-sampled and yielded to have less mean of amplitude[6][7].

It is always desired to increase the data rate over wireless channels. But high rate data communication is significantly limited by Inter Symbol Interference (ISI) and frequency selective fading nature of the channel. Multi-carrier modulation is used for such channels to mitigate the effect of ISI[8][9]. OFDM is a multi-carrier modulation scheme having excellent performance which allows overlapping in frequency domain. OFDM system provides an opportunity to exploit the diversity in frequency domain by providing a number of subcarriers, which can work as multiple channels for applications having multiple bit streams[8].

An Orthogonal Frequency Division Multiplexing (OFDM) system is a multi-carrier system which utilizes a parallel processing technique allowing the simultaneous transmission of data on many closely spaced, orthogonal sub-carriers[9][10[11].

II. PROPOSED MODEL: DWT-OFDM SYSTEM

This model ***i***s for transmission of DWT compressed data over OFDM channels. 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 $s1.s2/2$.
3) The coefficient vectors are uniformly quantized and binary coded with L bits/coefficient to form four bit streams.
4) The packetized bit streams are mapped on the OFDM system.

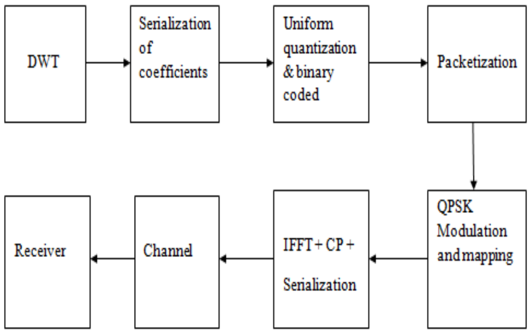


Figure 1.1 DWT-OFDM system.

Bit streams are packetized by chopping them into bit vectors of size *N_* bits. Four such vectors are contained in a packet. Training bits are added at the front of each bit vector to estimate the SNR of the sub channels at the receiver. We illustrate an OFDM system with an IFFT size of 128. For this system to get 128 bit streams 32 packets are arranged in parallel. Each bit vector in a packet is *m*-array modulated, and 32 packets are simultaneously transmitted through different sub channels set. Packets are sent through a slowly varying fading channel with are frequency selective. Due to the discarded or lost data vectors the reverse process is done at the receiver with suitable treatments

According to word size required for transmission, the input serial data stream is formatted e.g. for QPSK 2bit/word is used, and shifted into a parallel format. The data is then transmitted in parallel by assigning each data word to one carrier in the transmission.

The data to be transmitted on each carrier is then differential encoded with previous symbols, then mapped into a phase shift keying format. Since differential encoding requires an initial phase reference an extra symbol is added at the start for this purpose. The data on each symbol is then mapped to a phase angle based on the modulation method. For example QPSK the phase angles used are 0, 90, 180, and270 degrees. Constant amplitude signal was produced with the use of phase shift keying and which was chosen for its simplicity and to reduce problems with amplitude fluctuations due to fading. We use QPSK modulation after modulation the two bits are converted into symbols.

An IFFT is used to find the corresponding time waveform after the required spectrum is worked out. We apply inverse Fourier transform to convert time domain into frequency domain. Applying inverse Fourier transform it will generate OFDM symbols.

Cyclic prefix is used as a guard interval to mitigate the effect of ISI due to the multipath propagation. A selector block is applied as a cyclic prefix inserter to insert the last 16 subcarriers into the beginning of the OFDM symbols.

For the Additional White Gaussian Noise (AWGN) channel the received signal is equal to the transmitted signal with some portion of white Gaussian white noise added. To optimize the circuits in terms of their noise performance this is particularly important for discrete models operating on a restricted number space.

At the receiver side we do the reverse process to obtain the reconstructed image and we measure the quality of the image in terms of PSNR. The below are the equations which are used to calculate energy and power.

Here we calculate the energy using the following expression

Energy $= \sum_{n=1}^{N} x(n)$ (2.1)

Where

x(n) is OFDM signal

x^(n) is conjugate of OFDM signal

N is the total number of signals transmitted

For calculation of required power we used

Power= $\frac{1}{total\ no\ of\ samples}\sum_{n=1}^{N} x(n).x^*(n)$

(2.2)

III.RESULTS AND DISCUSSIONS

The obtained results here are two cases :

i)In the first case complete data is transmitted and received .

ii)In the second case only important data is transmitted and received.

Results obtained when the complete data is transmitted:

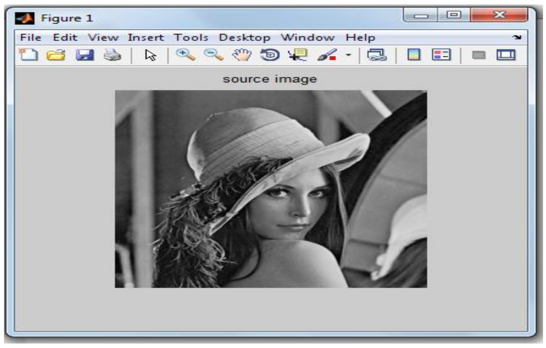


Figure 3.1 Source image

The figure 3.1 is the source image which is taken as an input, applied DWT and transmitted. As shown in figure 3.2 it is the DWT transformed image and here is divided into 4 sub images as LL, LH, HL, HH respectively, where LL is approximation and other are high frequency components.

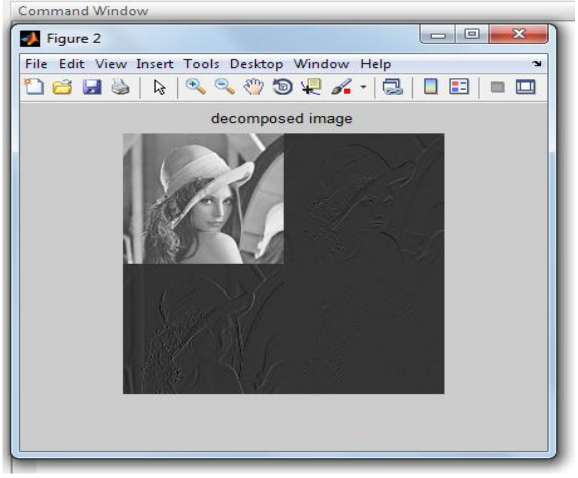


Figure 3.2 DWT transformed image

From the obtained DWT image we frame the bits into packets, these packets are transmitted through OFDM channel. The below figure 3.3 is the reconstructed image at the receiver.

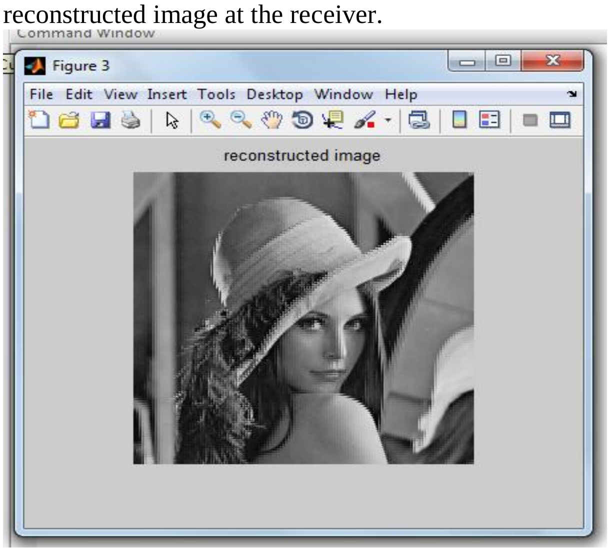
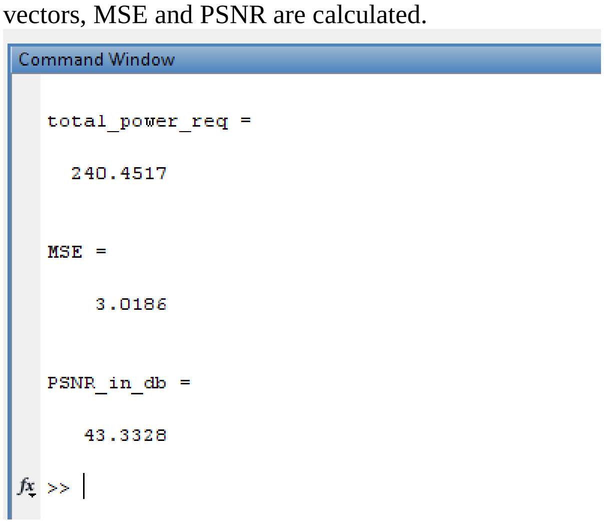


*Figure 3.3 Reconstructed image*As shown in figure 3.4 total power required to transmit all the data vectors, MSE and PSNR are calculated.


```
Command Window

total_power_req =

  240.4517


MSE =

    3.0186


PSNR_in_db =

   43.3328

fx >>
```

Figure 3.4 obtained mathematical values

Results obtained when only important data is transmitted:

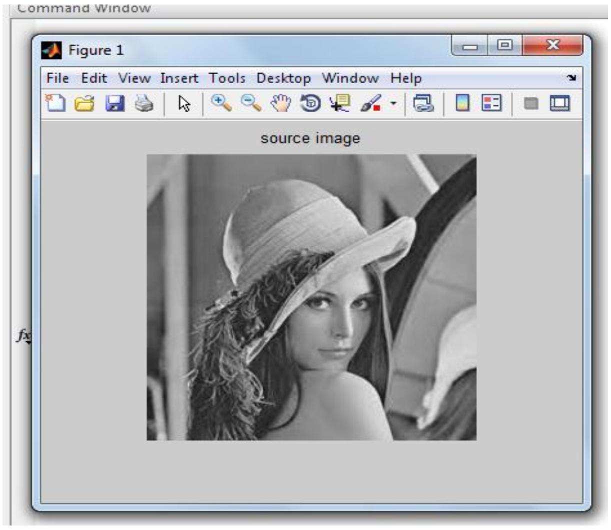


Figure 3.5 source image

The figure 3.5 is the source image which is taken as an input, applied DWT and transmitedt. As shown in figure 3.6 it is the DWT transformed image here is divided into 4 sub images as LL, LH, HL, HH respectively, where LL is approximation and other are high frequency components.

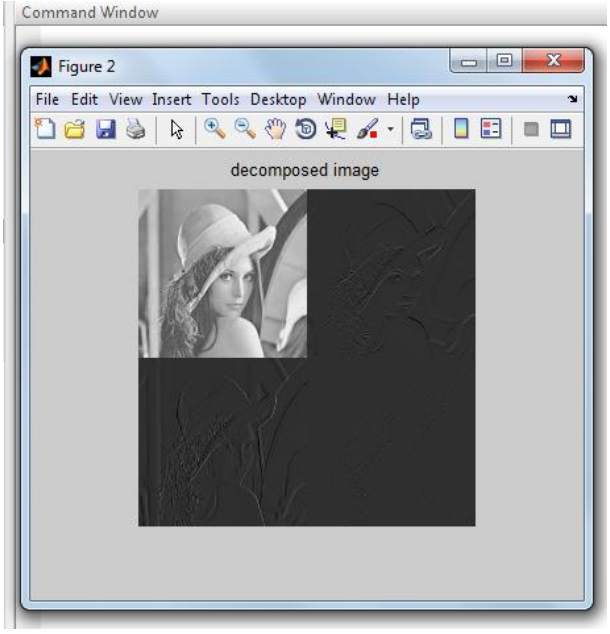


Figure 3.6 DWT image

From the obtained DWT image we form the bits into packets, these packets are transmitted through OFDM channel. The below figure 3.7 is the reconstructed image at the receiver. Here instead of sending complete data we are transmitting only important data (LL) and from that we are forming the image at the receiver side.

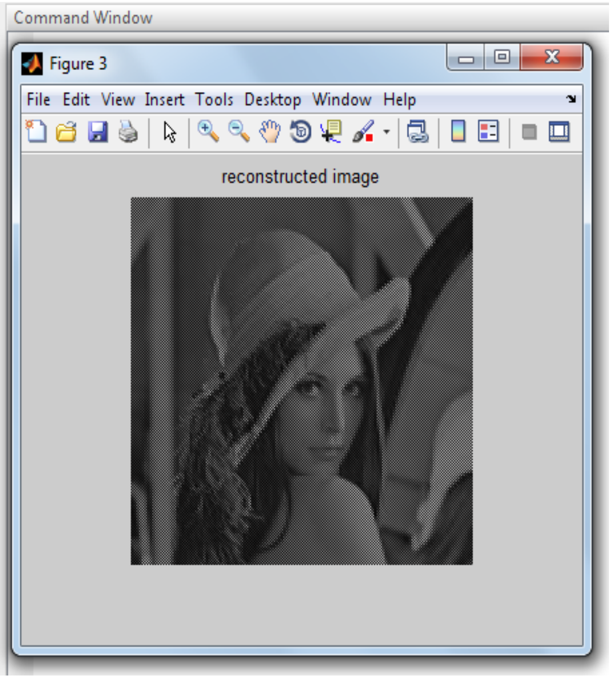


Figure 3.7 reconstructed image

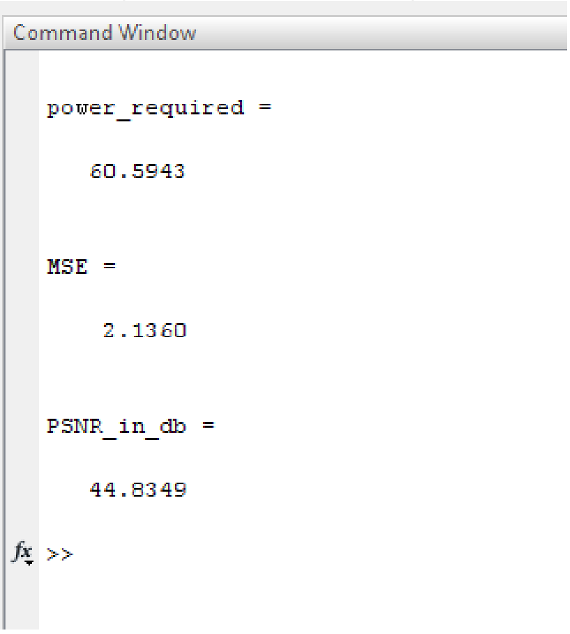


Figure 3.8 obtained mathematical values

To validate the analysis the analytical, formulated and simulated results are presented here. For simulations we have transmitted standard 'Lena' image of size 256 × 256 pixels. An OFDM system with $N \times M = 128$ subcarriers were simulated. In this way, 32 packets can be transmitted simultaneously through the OFDM system; QPSK is used as modulation scheme, which allowed transmitting 128 × 2 bits per OFDM symbol through a sub channel.

It is clear that instead of transmitting a complete data, the results are more efficient and qualitative when transmitted only the important data.

It is clear that nearly 75% of the power is saved when only important data is transmitted and received and are able to form good reconstructed image.

IV.CONCLUSION

Thus proposed an energy saving approach, where only important data is transmitted and received instead of sending the complete data and also compared the energy required to transmit the complete data and only important data. By this comparison it is clear that nearly 75% of energy is saved. We have measured the quality of the image using parameter like PSNR in both the cases and it is shown quality of image is better when only important data is transmitted instead of complete data. Our analytic observations on reception quality and energy saving performance are validated by extensive MATLAB simulations.

V.REFERENCES

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