Progressive Image Transmission Using OFDM System

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***Abstract*— Orthogonal frequency division multiplexing (OFDM) is growing up as an efficient modulation technique for wireless communications. OFDM provide high data rates and effective robustness to radio channel impairments. Various research laboratories in the world have expert teams working for the optimization of OFDM for various applications.**

***Index Terms*— OFDM, PAPR, SPIHT, LDPC**

I. INTRODUCTION

OFDM system has become the chosen modulation technique for various wireless multimedia transmission standards, such as DAB (Digital Audio Broadcasting) and DVB (Digital Video Broadcasting). It provides better immunity to multipath fading and impulsive noise. One more advantage of OFDM is high spectral efficiency. It also provides efficient modulation and demodulation by IFFT/FFT. OFDM mainly divides frequency selective channels into various parallel and non frequency selective narrow-band channels modulating signal into different frequencies. It improves the channel transmission performance. It has various applications in the area of wireless image and video communication systems.

OFDM system still has some limitations that have not been solved in the design of OFDM systems. One major problem is high Peak-To-Average Power Ratio (PAPR) of transmitted OFDM signals.

This research work has on two main goals, one is to reduce the PAPR (Peak to Average Power Ratio) of the OFDM signal and another one is to improve the quality of the received image. This system uses trigonometric transforms to reduce the PAPR.

II. SPIHT ALGORITHM

The SPIHT algorithm is based on the concept of wavelet transform. It restricts the necessity of random access to the whole image to small sub images. The SPIHT algorithm works on the principle of partial ordering by magnitude with a Set Partitioning Sorting algorithm, ordered bit plane transmission, and exploitation of self similarity across different scales of an image wavelet transform. The SPIHT concept is used for image transmission over the OFDM system in various research works because the SPIHT has a better rate-distortion performance for still images with comparatively lower complexity and is scalable or completely embeddable.

The SPIHT algorithm defines as well as partitions sets in the wavelet decomposed image by using a special data structure called as a spatial orientation tree. A spatial orientation tree is nothing but a group of wavelet coefficients that are organized into a tree rooted in the lowest frequency (coarsest scale) sub-band with offspring in various generations along the same spatial orientation in the higher frequency sub-bands. Figure shows a spatial orientation tree and parent-children dependency which is defined by the SPIHT algorithm across the sub-bands in wavelet image. The tree is defined in a way that each and every node has either no offspring (the leaves) or four offspring at the same spatial location in the next four sub-band level. The pixels which are present in lowest frequency sub-band tree roots are grouped into the blocks of 2x2 adjacent pixels, and in each block one of them is marked by star as shown in figure has no descendants. The SPIHT describes this type of collocation with one to four parent-children relationships.

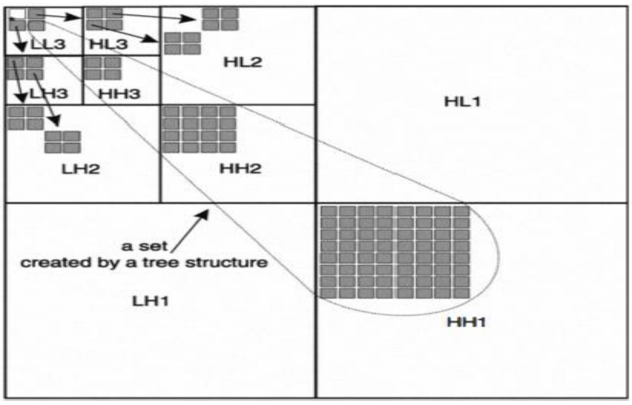

Fig. 1: Parent-children dependency and spatial orientation trees across wavelet sub-bands in SPIHT

The SPIHT algorithm mainly consists of three stages such as initialization, sorting and last one is refinement. In first step, it will sort the wavelet coefficients into three ordered lists such as list of insignificant sets (LIS), List of Insignificant Pixels (LIP), and the List of Significant Pixels (LSP). In second step, the SPIHT algorithm firstly defines a start threshold which is based on the maximum value in the wavelet pyramid, after that it sets the LSP as an empty list and puts the coordinates of all coefficients in coarsest level of the wavelet pyramid (i.e. lowest frequency band; LL band) into LIP and those which have descendants also into LIS.

In the second stage, in sorting pass, algorithm firstly sorts the elements of LIP and then the sets with roots in LIS. It performs a significance test for each pixel in the LIP against

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the current threshold and gives the output test result to output bit stream. Depending on the test outcome, all the performed test results are encoded as either 0 or 1, so that the SPIHT algorithm can directly produces a binary bit-stream. If the coefficient is significant, then its sign is coded and its coordinate is moved to LSP. During this sorting pass of LIS, SPIHT encoder performs the significance test for each set in LIS and gives the outputs as the significance information. If the set is significant, then it is partitioned into its offspring and leaves. This sorting and partitioning are performed until all significant coefficients have been found and stored in LSP.

After completion of this sorting pass for all elements in LIP and LIS, the SPIHT performs the refinement pass with the current threshold for all entries in LSP, but except those which have been moved to LSP during the last sorting pass. After that, the current threshold value is divided by two and both sorting and refinement stages are continuously performed until a predefined bit-budget is reached.

III. LDPC CODING

Various types of error correction codes have been applied to the OFDM system which improves the BER (Bit Error Rate) performance of the system. Out of these, LDPC codes have achieved the more attention mainly in the field of coding theory. LDPC coding method is nothing but just a class of linear block codes. LDPC coding provides highly reliable transmission for coding with comparatively low decoding complexity.

Combination of both, OFDM modulation technique and LDPC coding will definitely give an efficient and reliable method for large speed broadband wireless applications. The BER performance of the Low Density Parity Check Coding-Coded Orthogonal Frequency Division Multiplexing system is specialized by the sub-channels which have deep fade because of frequency selective fading. As per this type combination, various types of algorithms were introduced into LDPC-COFDM system which improves the BER by adaptive bit loading and power allocation of each subcarrier.

IV. SYSTEM DEVELOPMENT

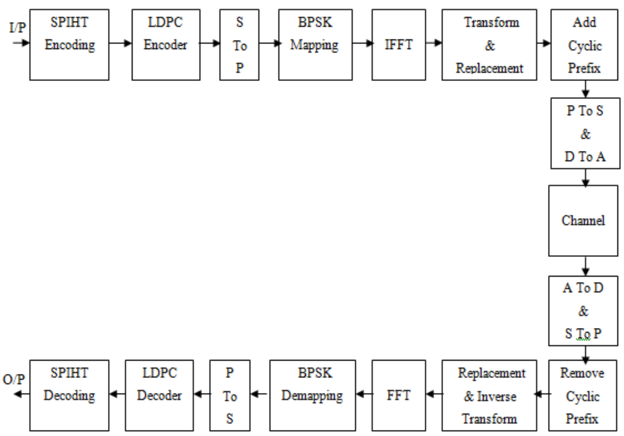


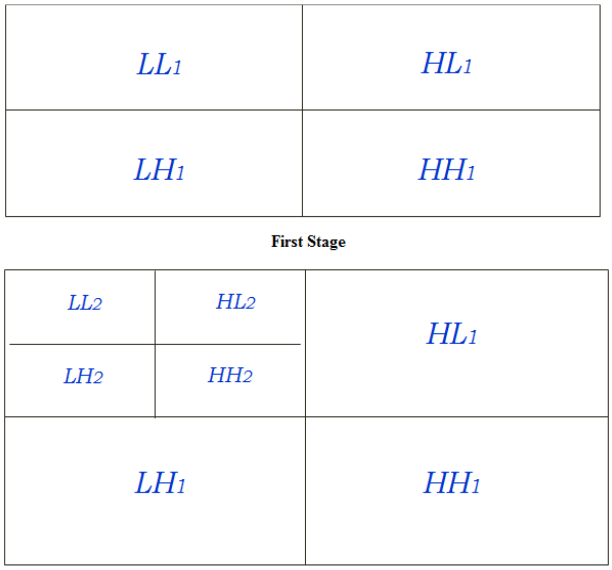
Fig. 2: OFDM system model

Source Coding:

SPIHT algorithm is used for source coding of an image. It is used for image compression. It uses wavelet decomposition .

Wavelet Decomposition:

This is the first step in SPIHT coding. It decomposes the original image into wavelet decomposed format. This results in four sub bands namely low-low, high-low, low-high and high-high.



Second Stage

Wavelet Decomposition

SPIHT Algorithm:

1. Initialization:
   Initialize Threshold, LIS, LIP, LSP
2. Sorting:
   Compare each pixel in LIS, LIP with threshold and group them in LSP
3. Refinement:
   Reduce the threshold by half and repeat sorting & refinement.

Channel Coding :

LDPC coding is used for channel coding. Channel coding means error control coding. It improves the Bit Error Ratio (BER).

Serial to Parallel Conversion:

Convert input serial bit stream into parallel form.

Subcarrier Mapping:

BPSK mapping is used for subcarrier mapping. Mapping is used to map the information bits onto the signal. Once the subcarrier is allocated the bits for transmission, they are mapped using a modulation scheme. This setup the OFDM signal in frequency domain.

Frequency to Time Domain Conversion:

IFFT is used to convert the signal to the time domain. It performs time domain transformation very efficiently and ensures carrier signals produced are orthogonal to each other.

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Trigonometric Transforms:

DCT / DST are used. It is used to reduce PAPR.

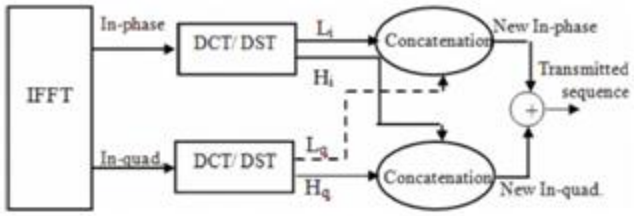


Fig. 3: Trigonometric transform and replacement process

Cyclic Prefix:

Cyclic prefix means prefixing the end of the symbol to the beginning. Cyclic prefix is used in multipath propagation. It is used to eliminate ISI.

Parallel to Serial Conversion:

It converts parallel input to serial form.

Digital To Analog Conversion:

It converts digital signal to analog form.

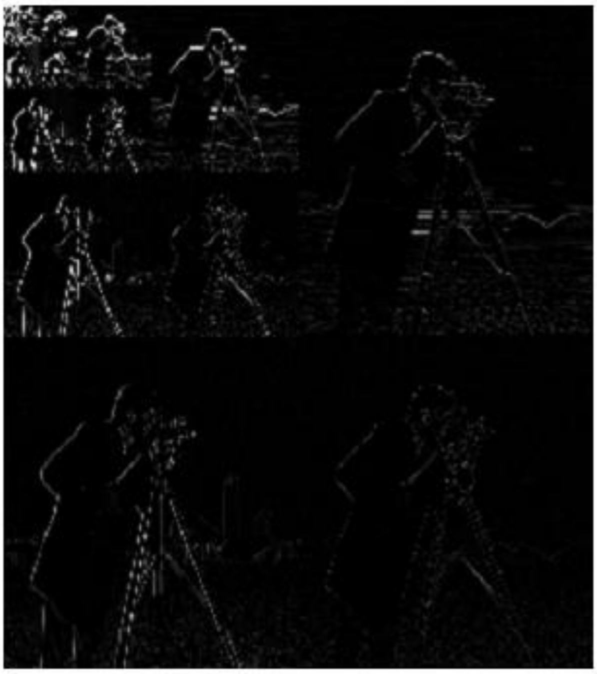
Channel:

Channel is a communication medium between transmitter and receiver. Most types of noise present in communication system can be modeled accurately using AWGN. These noise decrease SNR and efficiency of the system.

V. Performance Analysis

The simulation is carried out to study the transmission of SPIHT coded images on LDPC COFDM modified by Trigonometric transforms over an AWGN channel.

Original Image for Wavelet Transform



Partition Image Up to 8 Levels

Error in Received Image

Received Image after Encoding and Decoding

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Performance of the system using the SPIHT rate 0.5 for different images is as follows.

Image 1

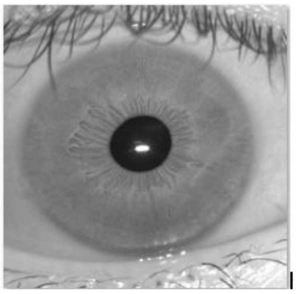

Image 2

Image 3

Image 4

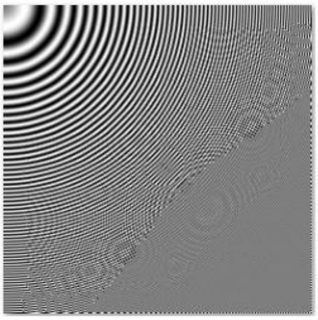

Image 5

Parameter	Image 1	Image 2	Image 3	Image 4	Image 5
PAPR	11.7544	10.6354	12.0619	12.7915	14.2488
Max Signal Level	0.95	0.95	0.95	0.95	0.95
RMS Signal Level	0.27574	0.29059	0.27249	0.2642	0.25054
Peak To RMS Power Ratio	10.7446	10.2889	10.8476	11.1157	11.5769
SNR	15.3025	15.3828	11.2312	28.0926	4.9442
PSNR	29.1416	33.8415	24.9686	38.4250	16.2783

Performance of the System for Different Images

VI. Conclusion

The highly efficient OFDM system with trigonometric transforms which supports image transmission using SPIHT compression technique is presented and studied. The effectiveness of this proposed system is verified through simulations over the AWGN channel. It is found that the proposed system must be designed carefully so that it can achieve the reduction in the PAPR without degrading the system performance.

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