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Performance Analysis of LDPC Coded PAPR Reduction Technique in OFDM System

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Abstract - *Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier modulation technique where the revolution of 4G wireless communication is focused. The main drawback of OFDM is high Peak-to-Average Power Ratio (PAPR) as high PAPR decreases the amplifier's efficiency. Using Low Density Parity Check (LDPC) code, it is possible to achieve reduction in high PAPR. With the help of MATLAB a comparative study will be carried out to analyses Bit Error Rate (BER) comparisons and Complementary Cumulative Distribution Function (CCDF) of different techniques of modulation.*

***Key Words*: OFDM, PAPR, LDPC, BER, CCDF, ABC, DE**

1. INTRODUCTION

Wireless communication is one of the important aspects of long distance communication. Along with the progress in technology rapid changes has been achieved in the field of wireless communication. Recent advances in wireless communication systems have increased the throughput and reliability of wireless channels. But still the bandwidth and spectral availability demands are endless. Researches in this field show that OFDM has become the modulation choice for high data-rate communication systems. But OFDM has the disadvantage of having large fluctuations in signal amplitude which has resulted in a high Peak-to-Average-Power Ratio (PAPR).

High PAPR is a major drawback of multicarrier transmission system which leads to power inefficiency in RF section of the transmitter. The PAPR of an OFDM signal can be reduced in several ways: amplitude clipping and filtering, cyclic coding, partial transmit sequence, selective mapping, and multiple signal representation techniques. Among which, coding based approaches have inherent error control capability and simplicity of implementation. But this approach has limitations like an exhaustive search to find the best codes and to store large lookup tables for encoding and decoding.

Among a variety of PAPR reduction techniques, the partial transmit sequence (PTS) scheme has attracted a lot of attention since it introduces no distortion in the transmitted signal and achieves significant PAPR reduction. However, the PTS phase factor information is required at the receiver as side information, which decreases the transmission efficiency or complicates the system design. LDPC code is a type of linear block codes. We are analyzing Low Density Parity Check (LDPC) code for PAPR reduction in OFDM systems with low searching complexity and good error correcting performance.

2. Over view of OFDM, PAPR, LDPC Code

2.1 OFDM

The basic principle of OFDM is to split a high-rate data stream into a number of lower rate streams that are transmitted simultaneously over a number of sub-carriers. Because the symbol duration increases for the lower rate parallel sub-carriers, the relative amount of dispersion in time caused by multi-path delay spread is decreased. Inter symbol interference is eliminated almost completely by introducing a guard time in every OFDM symbol. In the guard time, the OFDM symbol is cyclically extended to avoid inter carrier interference.

In OFDM system design, a number of parameters are up for consideration, such as the number of sub-carriers, guard time, symbol duration, sub-carrier spacing, modulation type per sub-carrier, and the type of forward error correction coding. The choice of parameters is influenced by system requirements such as available bandwidth, required bit rate, tolerable delay spread, and Doppler values. Some requirements are conflicting. For instance, to get a good delay spread tolerance, a large number of sub-carriers with a small sub-carrier spacing is desirable, but the opposite is true for a good tolerance against Doppler spread and phase noise.

2.2 PAPR

The OFDM signal, which results from super imposition of many individual sinusoidal sub-carriers, would have high amplitude, when these sinusoids are in phase at the IFFT input, and are thus added constructively to generate large amplitude corresponding to a high PAPR at the IFFT output.

The peak amplitude of OFDM signal could be N times that of a single carrier system, where N denotes the number of carriers. The mathematical representation of PAPR of an OFDM signal can be given as,

$$PAPR[x_n] = \frac{\max_{0 \le n < N} |x_n|^2}{E[|x_n|^2]}$$

Where $E\{.\}$ denotes average power.

PAPR can be expressed in 'dB' as follows,

$$PAPR\ (dB) = 10 \log_{10} PAPR(x_n)$$

2.3 LDPC Code

LDPC code is a type of linear block codes. The structure of LDPC is entirely expressed by the parity check matrix 'H' where 'H' is a sparse matrix (i.e. the matrix mostly consists of 0's and few 1's. The sparse is M*N parity check matrix where N > M and M=N-K. The message bits are said to be 'M', the parity bits are said to be 'K' and 'N' defines the total number of bits in the encoded data (i.e. M+K).

3. Proposed Technique

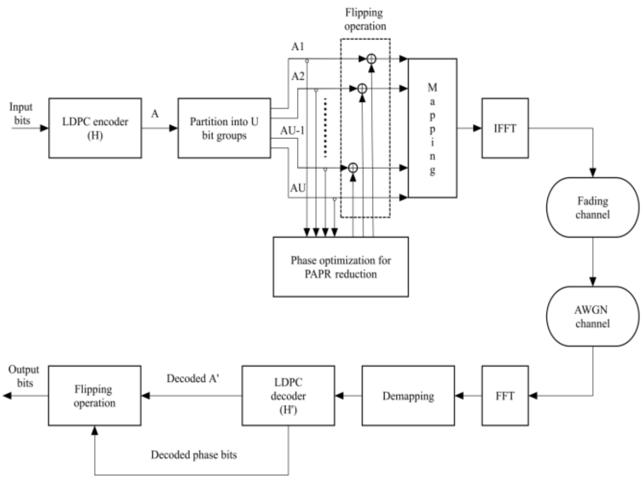

Fig -1: Name of the figure

The block diagram used in this paper appears in Figure 1. The input bit is first encoded by using LDPC encoder. The encoded data will be mapped. Then, they will be form into parallel and processed by IFFT block before processing through fading and AWGN channel. At the receiver, the reverse processes are applied, including the soft decision flipping and LDPC encoding.

4. Analysis

4.1 Numerical Results

Table 1 show the parameters values used for the OFDM system simulation. The PAPR of an OFDM system is depends on the messages which are transmitting. Here we are transmitting a 2048 bits random data.

Table -1: Simulation Parameters and Values

Parameter	Value
FFT size	64
Operating Frequency	2 GHz
Bandwidth (B)	4096 kHz
Useful Symbol Duration (T)	125 µs
Guard Interval (Tg)	¼ (31.25) µs
Total Symbol Duration (Tsymbol)	156.25 µs (with GI= T/4)
Coding Rate	½
Sub Carrier Spacing	8kHz
Channel	AWGN Channel

4.2 MATLAB Simulation

In order to verify the validity of our analytically derived technique, a MATLAB simulation program was performed. For the PAPR analysis of different modulation schemes we are transmit a random signal having 2048 bits and this signal is modulated using BPSK, QPSK and QAM modulations.

Fig. 2 graph shows that, QAM modulation scheme has minimum error compare to QPSK and BPSK modulation schemes. BPSK has the highest bit error rate compare to other modulations.

From Fig. 3 it is clear that, BPSK modulation scheme shows higher PAPR compared to QPSK and QAM modulation techniques. QAM has lowest PAPR. Because, QAM modulation changes the carrier amplitude. QPSK and QAM has slightest difference in their PAPR.

Fig. 4 graph shows that, ABC modulation scheme has minimum error compare to DE and LDPC-PTS modulation schemes.

From Fig. 5 it is clear that, LDPC-PTS modulation scheme shows higher PAPR compared to ABC and DE modulation techniques.

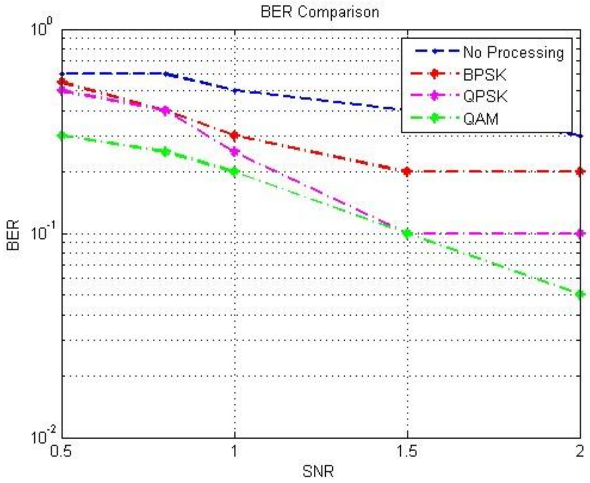

Fig -2: BER comparisons of BPSK, QPSK, QAM Techniques

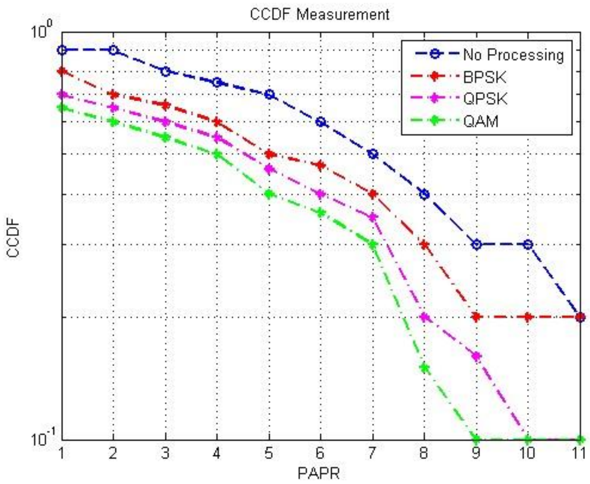

Fig -3: PAPR comparisons of BPSK, QPSK, QAM Techniques

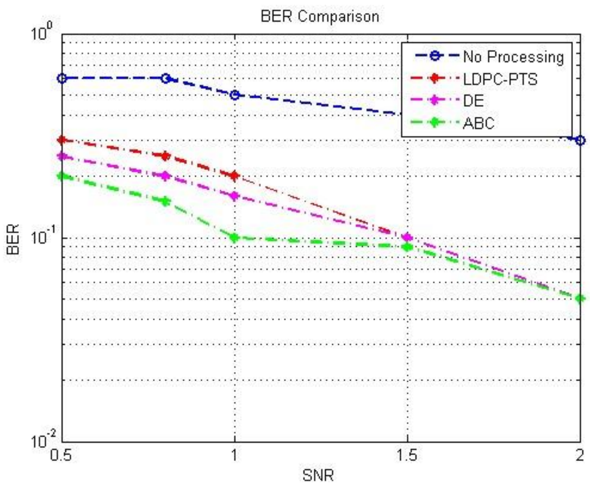

Fig -4: BER comparisons of LDPC-PTS, ABC, DE Techniques

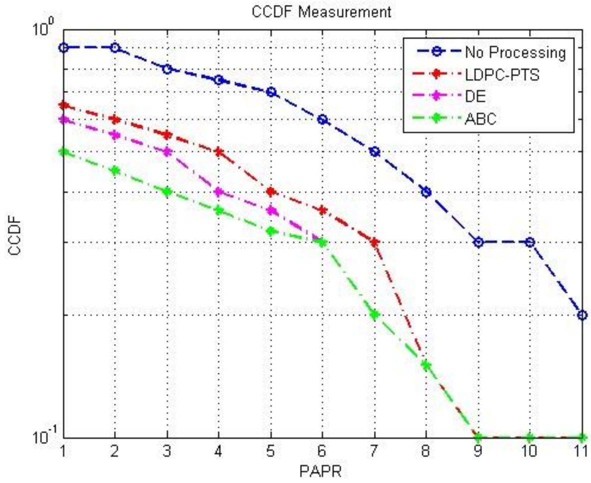

Fig -5: PAPR comparisons of LDPC-PTS, ABC, DE Techniques

5. CONCLUSIONS

From simulation results i,e, BER comparison (Fig.2) and CCDF measurement (Fig.3) of BPSK, QPSK and QAM we can conclude that, QAM modulation technique is most efficient technique compare with BPSK and QPSK modulation techniques. Because QAM has minimum bit error rate and lowest PAPR than other 2 techniques.

From simulation results i,e, BER comparison (Fig.4) and CCDF measurement (Fig.5) of LDPC-PTS, ABC and DE we can conclude that, ABC modulation technique is most efficient technique compare with DE and LDPC-PTS modulation techniques. Because ABC has minimum bit error rate and lowest PAPR than other 2 techniques.

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