Performance Evaluation of the OFDM System's LDPC Coded PAPR Reduction Method

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Abstract: Revolution of 4G wireless communication is completely focused on a multi-carrier modulation technique named as Orthogonal Frequency Division Multiplexing (OFDM). High Peak-to-Average Power Ratio (PAPR) is main drawback of OFDM system, because amplifier's efficiency decreases due to high PAPR. It is possible to reduce high PAPR by using Low Density Parity Check (LDPC) code. Comparative study of 2 parameters Bit Error Rate (BER) and Complementary Cumulative Distribution Function (CCDF) is carried out for different techniques of modulation with the help of MATLAB.

Index Terms: ABC, BER, BPSK, CCDF, DE, LDPC-PTS, OFDM, PAPR, QAM, QPSK

I. INTRODUCTION

Long-distance communication is a phenomenon that relies heavily on wireless communication. Wireless communication has experienced rapid changes along with the advancement of science. Wireless communication channels have become more reliable and efficient due to recent advances in wireless communication structures. Nevertheless, bandwidth and spectral availability requirements are endless. According to research in this area, OFDM has become the modulation of choice for communication systems that operate at excessive data rates. The disadvantage of OFDM is that it has large amplitude fluctuations, resulting in a high Peak-to-Average-Power Ratio.

In multicarrier transmission systems, high PAPR leads to inefficiency in the RF section, thus reducing power efficiency. The PAPR of an OFDM signal can be decreased 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 range of PAPR reduction techniques, the partial transmits sequence (PTS) scheme has attracted a lot of attention considering that 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 code. We are analyzing Low Density Parity Check (LDPC) code for PAPR reduction in OFDM systems with low searching complexity and good error correcting performance.

II. OVERVIEW OF LDPC, OFDM, PAPR

OFDM

Data streams are divided into lower rates by OFDM in order to be transmitted simultaneously over multiple sub-carriers, with a high-speed data stream as the source. Multi-path delay spread causes less relative dispersion in time among the lower rate parallel sub-carriers because the symbol duration increases. 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.

The number of sub-carriers, guard time, symbol duration, sub-carrier spacing, modulation type per sub-carrier, and forward error correction coding type are among the variables that must be taken into account while designing an OFDM system. System factors including available bandwidth, needed bit rate, tolerated delay spread, and Doppler values have an impact on the parameter selection. Conflicting requirements exist. For example, a large number of sub-carriers with a close sub-carrier spacing are preferred to get a good delay spread tolerance, but the opposite is true for a good tolerance to Doppler spread and phase noise.

PAPR

The OFDM signal, which is created by superimposing numerous distinct sinusoidal sub-carriers, would have a high amplitude if these sinusoids were in phase at the IFFT input. As a result, these sinusoids are combined constructively to provide a high PAPR at the IFFT output.

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

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

Where, E{.} denotes average power.

PAPR can be expressed in 'dB' as follows,

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

LDPC CodeLinear block codes include LDPC codes. The parity check matrix "H"—which is primarily made up of 0s and very few 1s—expresses the structure of LDPC in its entirety. The sparse parity check matrix is M*N, where M=N-K and N > M. It is common to refer to the message bits as "M," the parity bits as "K," and the overall number of bits in the encoded data (i.e., M+K) as "N."

III. PROPOSED TECHNIQUE

Figure 1 depicts the block diagram utilised in this paper. The LDPC encoder is used to first encrypt the input bit. The mapped information will be encoded. They will then be organized into parallel processing then processed by an IFFT block, fading, and an AWGN channel. The reverse techniques, such as soft decision flipping and LDPC encoding, are used at the receiver.

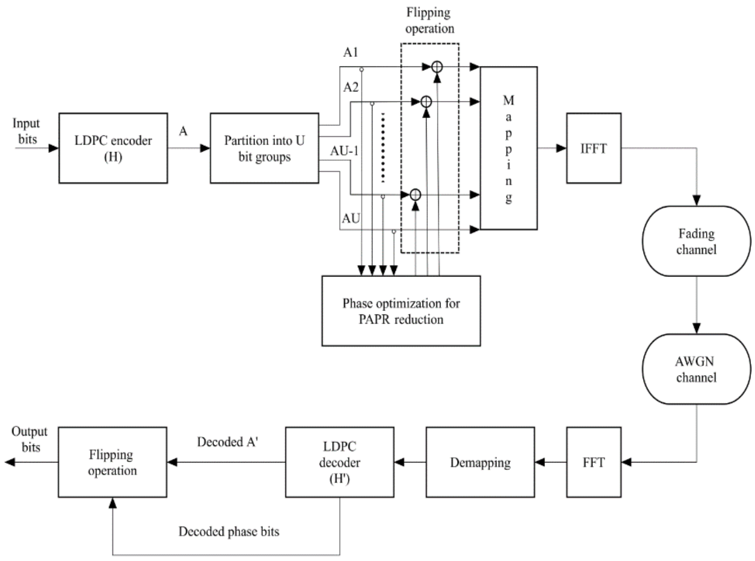

Figure 1 Block Diagram

IV. ANALYSIS

Numerical Results

The parameter values utilised for the OFDM system simulation are shown in **Table 1.** An OFDM system's PAPR is based on the messages that are being transmitted. Here, 2048 bits of random data are being transmitted.

Table 1 Simulation Parameters and Values

Parameter	Value
Bandwidth [B]	4096 kHz
Channel	AWGN Channel
Coding Rate	½
FFT size	64
Useful Symbol Duration [T]	1125 µs
Operating Frequency	2 GHz
Guard Interval [Tg]	¼ (31.25) µs
Sub-carrier Frequency	8 kHz
Total Symbol Duration [Tsymbol]	156.25 µs (with GI= T/4)

MATLAB Simulation

A MATLAB simulation programme was run to confirm the reliability of our analytically generated approach. We are transmitting a random signal with a 2048-bit length for the PAPR analysis of several modulation methods. This signal is modulated using the BPSK, QPSK, and QAM modulations.

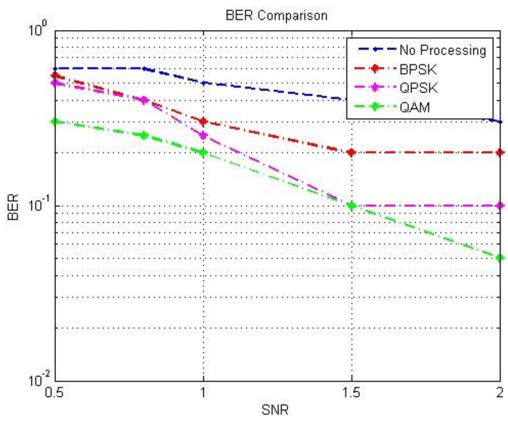

Figure 2 BER comparisons of BPSK, QPSK, QAM Techniques

According to the graph in **Figure 2**, QAM modulation has the least amount of error when compared to QPSK and BPSK modulation. The highest bit error rate among the various modulations is seen in BPSK.

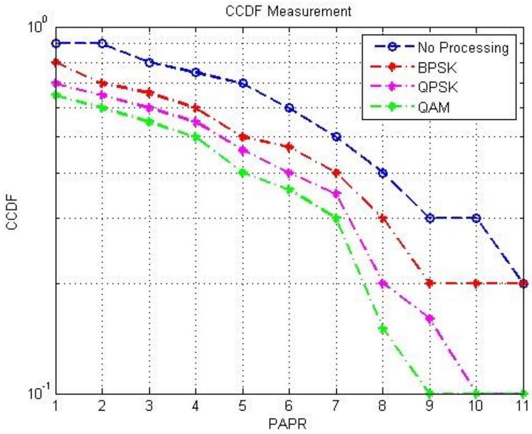

Figure 3 PAPR COMPARISONS OF BPSK, QPSK, QAM TECHNIQUES

It is evident from **Figure 3** that the PAPR for the BPSK modulation method is larger than that for the QPSK and QAM modulation schemes. PAPR is lowest for QAM. due to the fact that QAM modulation alters carrier amplitude. The PAPR of QPSK and QAM differs very slightly.

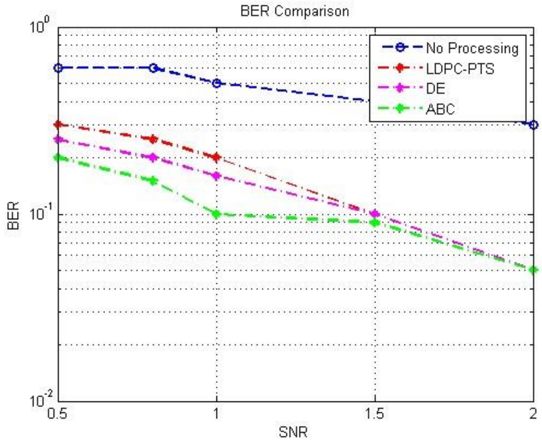

Figure 4 BER COMPARISONS OF LDPC-PTS, ABC, DE TECHNIQUES

According to the graph in **Figure 4**, the ABC modulation scheme has the least amount of error when compared to the DE and LDPC-PTS modulation schemes.

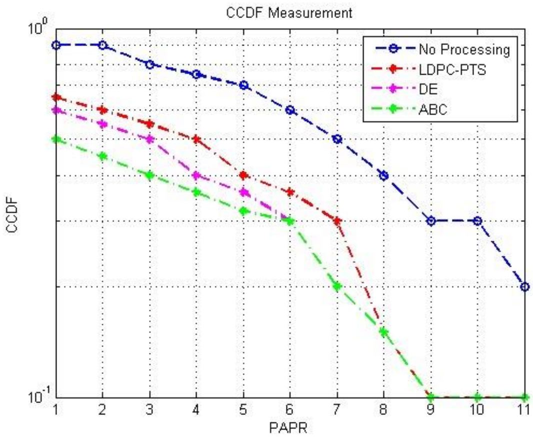

Figure 5 PAPR comparisons of LDPC-PTS, ABC, DE Techniques

It is evident from **Figure 5** that the LDPC-PTS modulation scheme exhibits a greater PAPR than the ABC and DE modulation methods.

V. CONCLUSION

We can deduce that the QAM modulation technique is the most effective method when compared to BPSK and QPSK modulation techniques from simulation results, such as BER comparison (**Figure 2**) and CCDF measurement (**Figure 3**). because QAM has a lower PAPR and bit error rate than the other two approaches.

We can deduce that the ABC modulation approach is the most effective strategy when compared to the LDPC-PTS and DE modulation techniques from simulation results, such as BER comparison (**Figure 4**) and CCDF measurement (**Figure 5**). Because ABC has a lower PAPR and bit error rate than the other 2 approaches.

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