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ORIGINAL ARTICLE

# 4G COMMUNICATION SYSTEM USING PAPR REDUCTION FOR MIMO-OFDM SYSTEMS

**Kailas[1] and Dr. R.C.Jain[2]**
[1]Ph.D Research Scholar, Department of Electronics and Communication,
Bundelkhand University, Jhansi.
[2]Professor, Department of Electronics and Communication,
Bundelkhand University, Jhansi.

**ABSTRACT:**

Multiple Input Multiple Output (MIMO) combining orthogonal frequency division multiplexing (OFDM) is of great interest to researchers and research laboratories around the world. OFDM is widely used in contemporary communication systems for better robustness and high spectral efficiency in multipath environments. The capability of wireless systems can be dramatically increased by using multiple input multiple outputs (MIMOs). The combination of MIMO and OFDM systems was found to be very beneficial. One of the major drawbacks of the OFDM-MIMO system is its high peak to average power ratio (PAPR) reduction. The peak power of the signal is an important design factor for band limited communication systems and must be minimized as much as possible. Several PAPR reduction techniques have been used to reduce PAPR. Partial transmission sequence (PTS) is the most well-known peak-to-ever power ratio (PAPR) reduction technique proposed for the MIMO-OFDM system. However the computational complexity of the traditional PTS method is enormous. This paper proposes a new partial transmit sequence (PTS) technique based on PTS for the new antenna MIMO-OFDM system, including DTCT wavelet transform (DWT) and discrete cosine transform (DCT) technology, which can achieve better PAPR performance. Low bit error rate (BER). Simulation results show that the proposed approach can reduce the BER and achieve better PAPR reductions compared to the previous PTS technique.

**KEYWORDS:** PTS, STBC, MIMO, OFDM, PAPR.

## INTRODUCTION

The combination of Multiple Input Multiple Output (MIMO) and Orthogonal Frequency Division Multiplexing (OFDM) (MIMOFFDM) is one of the high-speed emerging technologies for digital audio broadcasting (DAB), digital video broadcasting (future) as well as future wireless communication network technology. DVB), Medical Body Area Network (MBAN) application, the fourth and fifth generation of mobile networks (4G, 5G) output in the MIMO-OFDM system means superposition of multiple sub-carriers. Whenever the phase and frequency of these carriers are combined together, the instantaneous power output can be greatly increased and higher PPR may result in higher power amplifier (HPA) capacity. Much research work has been done to solve the problem of PAPRs associated with all types of multicarrier signals. So, several techniques such as clipping, tone reservations, nonlinear transformations, coding, gap mapping (SLM) and partial transmit sequences (PTS) are proposed. Improved approaches to PTS have been suggested that provide good results; However, the computational complexity is still completely unresolved. This paper proposes an approach to reduce PAPR in STBC MIMODM systems with less computational complexity.

Orthogonal Frequency Division Multiplexing (OFDM) is the most attractive technology for fourth generation (4G) wireless communication. The basic principle of OFDM is to segment high-rate data flows into low rate streams that are simultaneously transmitted by several sub-carriers. OFDM faces many challenges. The main challenges, on the line of the amplifier being non-linear, are, on average, to a large degree; Vibration of phase noise, frequency offset correction is required in the receiver. Large peak-to-average power (PAP) ratio that incorporates nonlinear components such as a power amplifier (PA) into the transmitter while distorting the signal. This is because the power amplifier on the transmitter enters the saturation region rather than in the linear region, causing distortion. A transmitted signal that results in increased BER to the next receiver. In other words, nonlinear distortion interferes with both in-band and out-bands signals. Therefore, PA requires approximately PAPR equalization for distortion-less transmission. This reduces the efficiency of the amplifier. Therefore, reducing PAPR is of practical interest.

OFDM has been proposed as a transmission mechanism for transmitting fast information over remote connections in multipath situations. In the most recent forty years, OFDM has developed a well-known strategy for wideband advanced correspondence, remote or over-the-counter, for use as a part of, for example, computerized TV and sound television, remote system administration and broadband web access. OFDM systems use digital-to-analog converter (DAC) and analog-to-digital converter (ADC) in the signal processing loop. To assist with high PAPRs, high accuracy DACs and ADCs are required, which are exceptionally expensive for a given detection rate of the framework. Although, low precision DAC and ADC are less expensive, their proportional movement is significant, and therefore SNR will decrease when the dynamic scope of DAC and ADC increases to assist PAPR. On this assumption, PAPR reduction is fundamental to the OFDM framework for better performance, greater scope coverage, and lower BER achievement. Most wireless communication systems used a high power amplifier (HPA) at the output of the transmitter to get enough transmit power to cover a large area. To achieve maximum energy efficiency, HPA is usually operated in or near the saturation region. When a high peak power signal passes through such HPA, the peaks are non-linearly clipped and induced at the inter-modulation distortion output. These additional interventions increase the BER.

MIMO has been developed for wireless systems for many years. In the mid-1980s, one of the earliest MIMOs for wireless communications applications came about. General Chat Chat Lounge Since then, many academics and engineers have made significant contributions to the field of MIMO. Now MIMO technology has become interested in the potential applications of digital television, wireless local area network, metropolitan area network and mobile communication. First, the MIMO system greatly increases the capacity of the channel, which is proportional to the total number of transmitters and receivers. Second, the MIMO system offers the advantage of spatial diversity: each single transmitted signal is detected by a complete detector array, which improves the robustness and reliability of the system while reducing inter symbol interference (ISI) and channel disappearance.

## LITERATURE REVIEW

**Naga Vaishnavi K. (2014)** are concluded in their study 'Performance of PAPR Reduction Techniques for MIMO-OFDM Systems in 4G Wireless Communication', that Mimo-OFDM is a very attractive technique for wireless communication due to spectrum performance and channel strength. One of the serious drawbacks in the OFDM system is that the composite communication signal can display very high PAPRs. Several major PAPR reduction techniques have been studied, such as IPerative clipping, selected mapping, and improved partial transmit sequence. The results of the simulation show that the clipping and filtering technique gives a good reduction of PAPR (10 dB) compared to other methods, but the good performance of PPR will be achieved by changing the PTS method.

**Vijaylaxmi M. and Reddy Ramalinga K. (2015),** observed in their study 'Adjacent Partitioning Based MIMO-OFDM System with Partial Transmit Sequence for PAPR Reduction' that Mimo-OFDM is a very attractive technique for wireless communication due to spectrum performance and channel strength. In this paper, the PTR reduction technique in the MIMO-OFDM system is based on adjacent partition based PTS. The results of the simulation have shown that the near partition based PTS gives better PAPR performance compared to traditional PTS in MIMO-OFDM systems.

**Sahraoui L., Messadge D. and Doghmane N. (2013),** observed in their study 'Analyses And Performance Of Techniques Papr Reduction For STBC MIMO-OFDM System In (4G) Wireless Communication' The results of the simulation are presented in this section. To implement the PAPR reduction of the MIMO-OFDM (STBC) signal, we created OFDM symbols of 301 and 601 tone lengths of 512 and 1024 samples for transmitting data and PAPR reductions. Each data carrying tone uses a QPSK modulation, an oversampling factor of L = 6 is applied, and 1000 randomly selected tone sets are generated in our simulation. The results of the PAR deduction in the simulation are presented as Complementary Density Function (CCDF) complementary to the PAPR of STBC MIMO-OFDM signals. Dimension of 512 lengths of crop reduction symbol, partial transmit, and select mapping for system (2x2) MIMO-OFDM (STBC), respectively, with clipping and filtering various methods. We have found that the reduction of clipping and filtering is about 4 dB, whereas in some materials, art clipping and filtering only reduced PAPR of 2 dB. This confirms that STBC coding helps profitable ways to reduce fluctuations in MIMO-OFDM envelope associations often with block code space-systems; It leverages the spatial space obtained by the ten nanometers separated. In other methods the SLM reduction of PTS and PAPR does not exceed 1.5 dB and 2 dB, respectively.

**Shukla Raj Lakshmi and Saini Garima (2015)** are observed in their study, 'A Hybrid Approach to Improve PAPR in MIMO-OFDM System' that, the obtained MIMO-OFDM frames are applied to the PTS block, respectively, and then to the clipping block. Also, for the better evaluation of the proposed method, only the results obtained from the clipping are considered. The resulting signal parameters change according to the signal processing applied by the two PAPR reduction methods. The PTS method works on a frequency-domain signal until the best signal derivation is actually detected. The main idea of this approach is to change the phase of the signal generating vector. This method treats the vectors of the signal as grouped into degenerate blocks. Vectors within a block can be nearly displaced, or they can be interleaved with vectors representing another block. The algorithm implements a phase shift that is repeated for each block until the signal type with the lowest PAPR is detected. In the present work, the PTS method was applied considering all the same lengths of adjacent or adjacent blocks. To add further, for a better PAPR deduction, the proposed PTS method switches the position between these blocks.

**MIMO-OFDM MODEL**

Multiple Input Multiple Output Orthogonal Frequency Division Multiplexing is a technique that uses multiple antennas to transmit and receive radio signals. The block diagram of the desired scheme for the MIMO-OFDM system is shown in Figure 1 which has antennas on the transmitter and receiver side. When too many throughputs are targeted, the multipath character of the environment makes the MIMO channel frequency-selective. OFDM can convert such frequency-selective MIMO channels into sets of parallel frequency-flat MIMO channels and also increase the efficiency of frequency. Therefore, MIMO-ODM technology has been invented as the infrastructure for next-generation wireless networks. The MIMO wireless system, combined with OFDM, allows for easy transmission of symbols across time, space, and frequency. The MIMO-OFDM base station takes advantage of the multipath properties of the environment using ten antennas that do not have LOS and uses both MIMO and OFDM gains. The combination of MIMO and OFDM technology will impact the evolution of wireless LANs and is a leading candidate for future fourth generation (4G) wireless communications systems. Therefore, the MIMO-OFDM system has become a welcome proposition for 4G mobile communication systems. The advantage is the extremely high capacity, spectral efficiency and reliability of improved communication, that is, the bit error rate (BER) achieved by reasonable computational complexity.

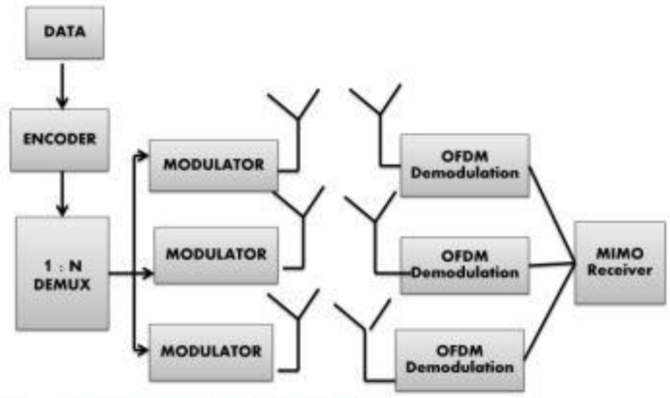


**Figure: MIMO-OFDM Model**

The received signal at $j^{th}$ antenna can be expressed as

$$Rj\,[n,k] = \sum H_{ij}[n,k]X_i[n,k] + W[n,k] \quad (1)$$

Where H is the channel matrix, X is an input signal, and w is the noise with zero medium and variance. Also shows $X_i$ [n, k] data block + transmit antennas, $n^{th}$ time slots and $k^{th}$ sub-channel index of OFDM. Here i and j receive the antennas indexed and the antenna coordinates respectively.

MIMO-OFDM system models with NR receive ten antennas and can be provided as NT transmit antennas

$$\begin{bmatrix} Z_1 \\ Z_2 \\ \vdots \\ Z_N \end{bmatrix} = \begin{bmatrix} H_{1,1} & H_{1,2} & \dots & H_{1,NT} \\ H_{2,1} & H_{2,2} & \dots & H_{2,,NT} \\ \vdots & \vdots & \ddots & \vdots \\ H_{NR,1} & H_{NR,2} & \dots & H_{NR,NT} \end{bmatrix} \begin{bmatrix} A_1 \\ A_2 \\ \vdots \\ A_{NT} \end{bmatrix} + \begin{bmatrix} M_1 \\ M_2 \\ \vdots \\ M_{NT} \end{bmatrix} \quad (2)$$

Where Z represents the O / P data vector, H represents the channel matrix, A indicates the I / P data vector and M represents the noise vector. The wireless channel used is the AWGN channel. The CP is removed after receiving the signal, and then the aerodynamics is also removed from the received main signal. After that, the time-consuming signal can be converted to a frequency domain by taking the FFT of the received signal. The order of each OFDM block is then assigned to the channel prediction block where the received pilot changed by the channel is compared to the original sent airman. Channel prediction blocks contain algorithms that are implemented to estimate a channel.

**Schemes of PTS:**

Several PAPR reduction techniques are available in the literature. These methods are basically divided into four types

1. Distortion of Signal
2. Method of Coding
3. Techniques of Probabilities / Scrambling
4. Methods of Pre-Distortion

Each method has some disadvantages and qualities. There are always trade-offs between PAPR reductions and some factors such as bandwidth, computational complication, mediocre influence, etc.

- High ability to reduce PAPR with some detrimental side effects such as in-band distortion and out-of-band radiation.
- Low implementation complexity: High implementation and computational complexity increase the delay of transmission which reduces data rate.
- Low average power: Any increase in average power requires a large linear operation region in the HPA and results in a loss of BER efficiency.
- No bandwidth extension: Bandwidth is the cheapest resource for any wireless communication system. Therefore, PAPR must be reduced without increasing the bandwidth of the transmitted signal. Side information due to bandwidth expansion reduces data code rate. Therefore, the loss in bandwidth due to the side information must be avoided or at least kept to a minimum.
- No loss of BER performance: PARR should be reduced but not at the cost of BER deduction. The BER performance should be the same as the original OFDM system.
- No additional energy required: Any increase in power requirements reduces the efficiency of the system, and power is an important resource for any wireless communication system. Therefore, any PAPR reduction plan should reduce PAPR without the need for electricity.
- No pigmentation: the PAPR reduction technique should not destroy orthogonally the OFDM signal

Several PAPR reduction techniques have been proposed in the literature. In this section we explore some of these techniques and discuss their advantages and disadvantages in terms of PAPR reduction capabilities, BER degradation and computational complication. PAPR deduction plans are mainly divided into two types.

1. Distortion Based Techniques
2. Non-distortion Techniques

**Reduction Techniques of PAPR:**

1. SISO PTS Scheme: In the SISO-PTS scheme, the original data sequence M partition in the frequency domain is subdivided into sub-block Xv (v = 1, 2 ... M) of the same length.

$$X = \sum_{v=1} Xv^{M} \qquad 3$$

By multiplying the coefficients of the weights across all sub-carriers in each sub block, we get a new frequency sequence.

$$X' = \sum_{v=1}^{M} b_v X_v \qquad 4$$

Finally, the sub-block (V-1) in each infected ten nut must be optimized, and the candidate sequence with the lowest PAPR is chosen to communicate independently. Assume that W is the allowed phase weight factor. In order to achieve optimal weight loss factors for each transmitting ten to ten nutrients, combinations must be tested to obtain the minimum PAPR.

**Alternate PTS (A-PTS)**

In, the idea of alternative optimization is introduced and PTS can also be implemented in multiple antenna OFDM systems, it is referred to as optional PTS (A-PTS). Unlike normal PTS, only half the sub-blocks in A-PTS require only phase weight components. That is, starting from the first sub block, each optional sub block is not changed, and the phase weighting factors are optimized only for the remaining sub blocks, which reduce the computational complexity. Thus, computational complexity is greatly reduced at the cost of degradation of PAPR functionality. The PAPR functionality is further enhanced to increase the number of applicants for the local sub block circular number for the A PTS scheme.

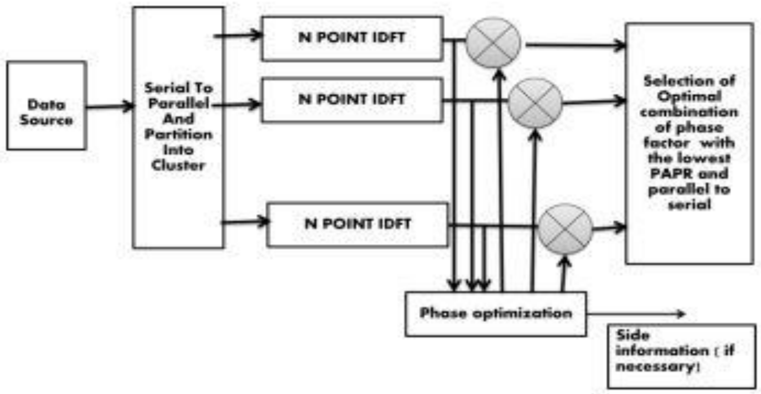


**Fig-2 PTS Block Diagram**

**Artificial Bee Colony Technique:**

Reduce the computational complication of the PAPR deduction process in the IPTS scheme. The ABC algorithm is implemented to reduce the weight in the IPTS scheme, which can achieve PAPR performance with less computational complication.

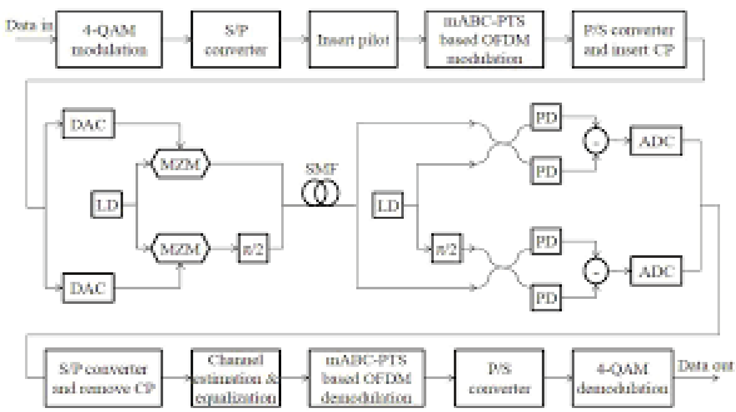


**Fig: Block Diagram of Artificial Bee Colony Technique**

**CONCLUSION:**

Although all techniques for individual and hybrid effects provide good results, each method has its own specific drawbacks. Here in this paper the PAPR deduction is applied to the MIMO-OFDM system for 4G communication which has the number of 256 and 512 sub-carriers according to the OFDM system. Significant difference is the decrease in PAPR value by approximately 2 dB.

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