PERFORMANCE ANALYSIS OF DWT AND DCT BASED SCHEME FOR PAPR REDUCTION IN MIMO-OFDM COMMUNICATION SYSTEMS

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Abstract: - With the modernization of the technologies wireless communication systems are facing several demands for high-speed wireless services such as switched traffic, Internet Protocol (IP) data packets and multimedia. This implies that a future generation system will be aiming at wideband, broadband and Ultra Wide Bandwidth (UWB), which are capable of achieving the high spectral efficiency by using the various wireless techniques. However, the system design should satisfy the customer's requirements without any compensation. A wellbalanced complexity, flexibility, data rate, Quality-of-Service (QoS) and cost are the important considerations for commercial applications particularly. The great progress made in the fields of microelectronics, signal processing, mobile computing, etc., thrive in achieving spectral efficiency with high flexibility [1].

In this Paper, a method is proposed for minimization of PAPR in MIMO-OFDM systems using PTS method. The PTS is concatenated with DCT and DWT signal processing algorithm to improve the efficiency and reduction of peak power of the MIMO-OFDM system. Because of autocorrelation of DCT the average power will be reduced. Using DWT, the data is divided into high and low coefficient such that the cyclic prefix can be avoided. By using PTS method, the optimum phase's factors are selected to reduce the average power. Hence it is achieved that MIMO- OFDM signals with less PAPR.

Simulation results show that the proposed approach can reduce computationally complexity and achieve a better PAPR reduction and bit error rate performances compared to PTS technique. The proposed system is showing improvement of 13.23% peak to average power ratio (PAPR) than existing MIMO-OFDM based on PTS technique.

1. INTRODUCTION

The prime idea of using OFDM was normally to use multiple sub-carriers to transmit the signal in order to avoid either carrier or symbol related interference. The design principle of OFDM is quite simple as it incorporates the features of narrowband in its sub-channels for ensuring flat fading. Apart from its usage in audio and video broadcasting, OFDM is currently used in 4G networks [6], LTE (Long-Termed Evolution) network, and upcoming 5G network [7]. Although, OFDM is one of the most demanding technology for present day multi-carrier based communication system, but still the technique suffers from certain pitfalls. This chapter discusses about one of the potential and an unaddressed problem in OFDM called as PAPR (Peak-to-Average Power Ratio) and proposes a solution to overcome it.

2. WIRELESS COMMUNICATION

Wireless communication is characterized as the exchange the data between two or more gadgets with no electrical or wire associations. Wireless communication frameworks have expanded the throughput over channels and systems. At same time the unwavering quality of Wireless communication has been expanded. The principle power behind Wireless communication is guarantee of convenience, versatility and openness.

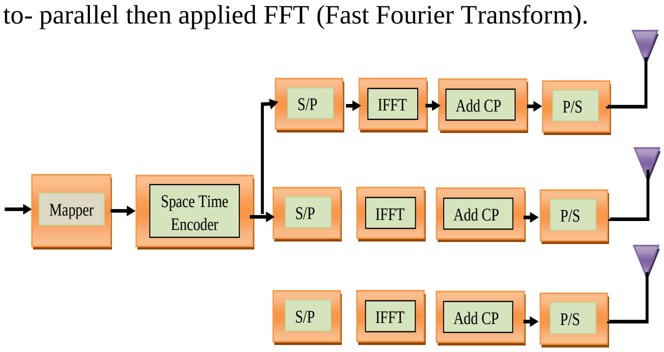
Wireless communication is a standout amongst the most dynamic zones in the correspondence field today. While it has been a theme of study following the 1960s, the previous decade has seen a surge of exploration exercises in the range. This is because of an intersection of a few components. To begin with, there has been an unstable increment sought after for tie less availability, driven so far fundamentally by cell telephony yet anticipated that would be soon obscured by remote information applications. Second, the sensational advancement in VLSI innovation has empowered little region and low-control execution of complex sign preparing calculations and coding systems. Third, the achievement of second-era (2G) advanced remote gauges, specifically, the IS-95 Code Division Multiple Access (CDMA) standard, gives a solid show that smart thoughts from correspondence hypothesis can have a noteworthy effect practically speaking. The examination push in the previous decade has prompted a much wealthier set of viewpoints and devices on the most proficient method to impart over remote channels, and the photo is still all that much advancing [13]. There are two crucial parts of Wireless communication that make the issue testing and intriguing. These angles are all things considered not as noteworthy in wire line correspondence. To begin with is the wonder of blurring: the time variety of the channel qualities because of the little scale impact of multipath blurring, and in addition bigger scale impacts, for example, way misfortune by means of separation constriction and shadowing by impediments. Second, not at all like in the wired world where each transmitter–receiver pair can frequently be considered as a segregated point-to-point join, remote clients impart over the air and there is noteworthy obstruction between them. The obstruction can be between transmitters speaking with a typical recipient (e.g., uplink of a phone framework), between signs from a solitary transmitter to numerous beneficiaries (e.g., downlink of a cell framework), or between diverse transmitter–receiver sets (e.g., impedance between clients in distinctive cells). Instructions to manage blurring and with impedance is key to the configuration of Wireless communication frameworks and will be the focal subject of this book. In spite of the fact that this book takes a physical-layer viewpoint, it will be seen that truth be told the administration of blurring and obstruction has implications over various layers. Generally the outline of remote frameworks has concentrated on expanding the air's dependability interface; in this setting, blurring and obstruction are seen as disturbances that are to be countered. Late center has moved more towards expanding the ghastly proficiency; connected with this movement is another perspective that blurring can be seen as a chance to be abused. The fundamental target of the book is to give a brought together treatment of Wireless communication from both these perspectives. Notwithstanding conventional points, for example, differing qualities and impedance averaging, a generous segment of the book will be committed to more cutting edge themes, for example, sharp and numerous info different yield (MIMO) correspondence. An essential part of this book is the framework view accentuation: the fruitful execution of a hypothetical idea or a procedure obliges a comprehension of how it interfaces with the remote framework in general [14]. Dissimilar to the determination of an idea or a strategy, this framework perspective is less pliable to scientific details and is basically obtained through involvement with planning real remote frameworks. We attempt to help the per user add to some of this instinct by giving various cases of how the ideas are connected in genuine remote frameworks. Five illustrations of remote frameworks are utilized.

Some of the challenges in wireless communication are:

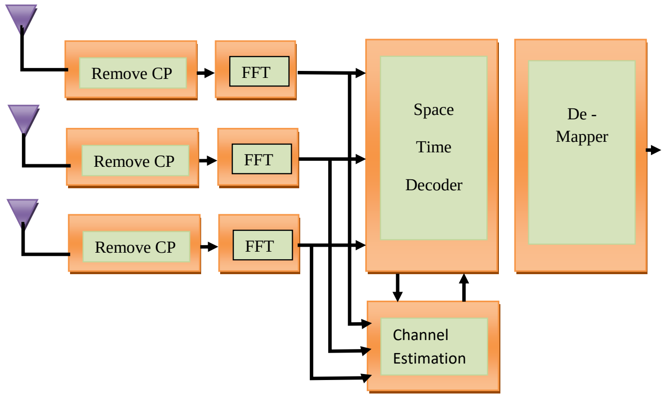
- A need for high data rates
- Quality of service
- Mobility
- Portability
- Connectivity in wireless networks
- Privacy & Security

3. OFDM SYSTEM MODEL

The implementation of the system model in MATLAB software, with the main block described below. A random binary signal is generated in a serial manner. To analyze a signal in the time domain, apply IFFT (Inverse Fast Fourier Transform) and convert it from parallel-to-serial OFDM signal. The OFDM signal is added the Cyclic Prefix (CP) because of the remove interference between OFDM symbols. This signal is then feed through an Additive White Gaussian Noise (AWGN) channel. At the receiver site, the OFDM signal is CP removed and the signal is converted from serial-to- parallel then applied FFT (Fast Fourier Transform).



(a) MIMO OFDM Transmitter



(a) MIMO OFDM Transmitter

(b) Figure 1: Design of MIMO – OFDM System

Then Received the output of FFT signal, and then signal converted from parallel-to-serial converter to each symbol for analysis in the frequency domain is received. After demodulation, the signal is cross-correlated with that a time-shifted in demodulation signal.

The outputs of the OFDM demodulators are finally separated and passed through MIMO decoder as ML detector. This data is demodulated and then decoded. The MIMO-OFDM device modified into applied with the useful resource of MATLAB / SIMULINK. The execution device is binary facts this is modulated the use of QAM and mapped into the constellation elements. The virtual modulation scheme will transmit the records in parallel by means of manner of assigning symbols to every sub channel and the modulation scheme will determine the phase mapping of sub-channels thru a complex I-Q mapping vector show in figure 3.6. The complicated parallel facts stream must be converted into an analogue signal this is suitable to the transmission channel.

The radio stripe system, described earlier, represents a cost-efficient build practice of a ubiquitous “cell-free” Massive MIMO system. Furthermore, it might be an ideal solution in terms of flexibility and scalability of the deployment, and to provide coverage to environments where large and visible installations, typical of centralized network architectures, are not admissible either because of regulation or space constraints.

The complicated parallel facts stream has to be transformed into an analogue sign that is suitable to the transmission channel. It is performed to the cyclic prefix add to the baseband modulation signal because the baseband signal is not overlap. After than the signal is splitter the two or more part according to the requirement.

4. PAPR IN OFDM SIGNAL

In OFDM modulations technique, the blocks of N data symbols, $\{X_n,\ n = 0,\ 1\ \ldots\ldots..N\text{-}1\}$, is designed with each symbols modulating the corresponding subcarrier from a set $\{f_n,\ n = 0,\ 1\ \ldots\ldots..N\text{-}1\}$ where N is the number of subcarriers. The N subcarriers are chosen to be orthogonally, i.e. $f_n = n\Delta f$, where $\Delta f = 1/NT$ and T be the original symbols period.

The resultant baseband OFDM signal x(t) of a block can be expressed as

$$x(t) = \frac{1}{\sqrt{N}}\sum_{n=0}^{N-1} X_n e^{j2\pi f_n t}, 0 \le t \le NT$$

……3.5

The PAPR of the transmitted OFDM signal x(t), is then given as the ratio of the maximum.

5. DCT TRANSFORM

The greatest value of the auto correlation is average power of inputs sequence. DCTz theoretically spreads the original N-point data sequences to 2N-points sequences by doing mirror–extension of the N-points data sequence. Subsequently the both end of data is continuously continuous in the DCTs, the lower orders of component will be conquered in transforms domain signal after converted by DCT. The DCT is a just like Fouriers transform. The impression to use the DCTs transform is to decrease the autocorrelation of the inputs sequences to decrease the peak to average powers problem and transmitted signals does not need any side informations at receiver. In the section, we momentarily review DCT transforms. The 1D discrete cosine transform (1D DCT) A[k] of a sequence a[n] of lengths N is well-defined as:

$$A[k] = a[k]\sum_{n=0}^{N-1} a[n]\cos\left[\frac{\pi(2n+1)k}{2N}\right]$$

…..4.6

For k = 0, 1 . . . N- 1, the inverse DCT is defined as

$$a[n] = \sum_{n=0}^{N-1} a[k]A[k]\cos\left[\frac{\pi(2n+1)k}{2N}\right]$$

……4.7

n= 0, 1… N-1 where a[k] is defined as:

$$a[k] = \begin{cases} \sqrt{1/N} & \text{for } k = 0 \\ \sqrt{2/N} & \text{for } k = 1,2,\ldots\ldots N-1 \end{cases}$$

……4.8

The basis sequences of the 1D DCT are real, discrete-time sinusoids defined by:

$$C_N[n,k] = \cos\left[\frac{\pi(2n+1)k}{2N}\right]$$

……4.9

The DCT basis consists of the following N real sequences.

$$C_N[n,0], C_N[n,1], \ldots\ldots\ldots\ldots\ldots . C_n[n, N-1]$$

……4.10

The equation (4.6) is expressed in matrix

$$A = C_N a$$

……4.11

Where A are both the vector with Nx1 and CN is a DCT transform matrix with N x N.

The row (or column) of the DCT matrix CN are orthogonal matrix vectors. Then we can use this property of the DCT matrix and reduce the peak power of OFDM signals. DCT can reduce the autocorrelation between the each component of OFDM signal this is the root cause to reduce PAPR.

6. RESULTS AND DISSCUSSION

The analysis of the Performance Analysis of DWT and DCT based Scheme for PAPR Reduction in MIMO-OFDM Communication Systems has been carried out using MATLAB software. The entire simulation parameters considered for this analysis is summarized in Table 1.

Table 1: Parameter of 2×2 MIMO-OFDM Systems with IFFT = 256

S.No.	Name	Parameter
1	Number of subcarriers (N)	64,128,256,512,1024
2	Modulation Scheme	BPSK, QPSK, 16-QAM
3	IFFT	256
4	Bits per symbol	8, 10 and 12
5	Coding technique	Linear block coding

In the OFDM System under consideration, modified SLM technique is applied to the encoded information in the sub blocks, which is modulated by QAM modulation. The performance evaluation is done in terms of CCDF.

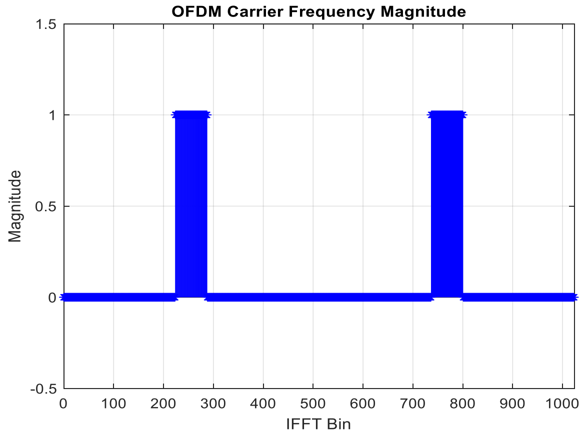


Fig 2 OFDM Carrier Frequency Signal

Fig. 2 shows the OFDM Carrier Frequency Signal performance for DCT based system with different subcarriers 64,128,256,512 and 1024 in OFDM system. Carrier count = 64, Bits per symbol = 10, Symbols per carrier =8, and SNR = 10. it is evident that the values of magnitude are obtained as 1 for different IFFT bin.

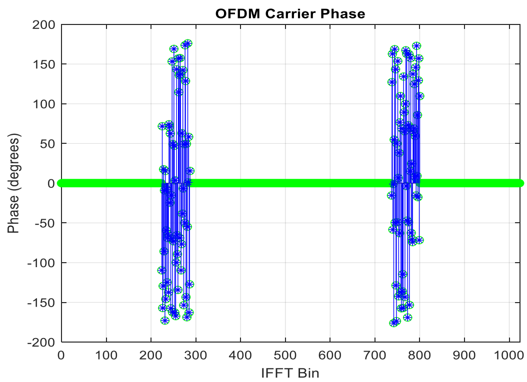


Fig 3 OFDM Carrier phase Signal

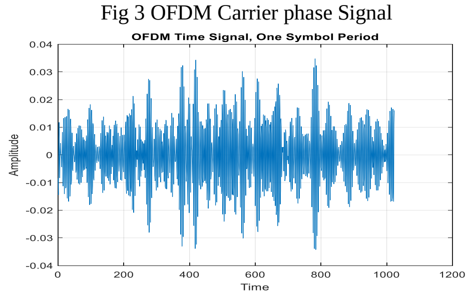


Fig 4 OFDM Time Signal for one symbol Period

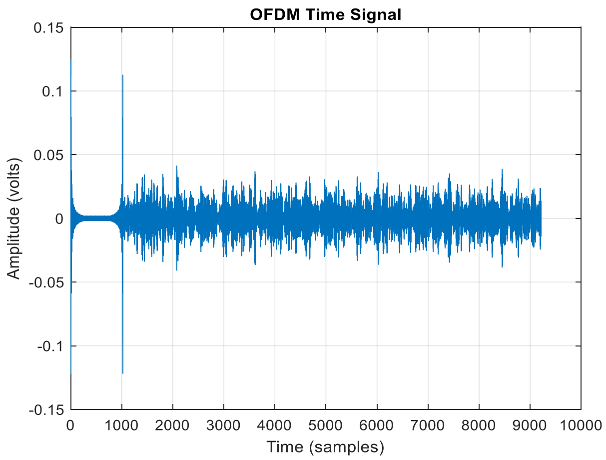


Fig 5 OFDM Time Signal

Fig. 5 shows the OFDM Carrier Phase Signal performance for DCT based system with different subcarriers 64,128,256,512 and 1024 in OFDM system. Carrier count = 64, Bits per symbol = 10, Symbols per carrier =8, and SNR = 10. It is evident that the values of magnitude are different for different values of IFFT bin and it is fluctuating between 200 to 300 and 700 to 800. Fig 5.3 and 5.4 shows OFDM Time Signal for one symbol Period and OFDM Time Signal respectively for differet time samples

Figure shows the different value of BER in different PAPR for MIMO-OFDM 2×2 system. It is clearly that the QAM modulation technique is best compared to other.

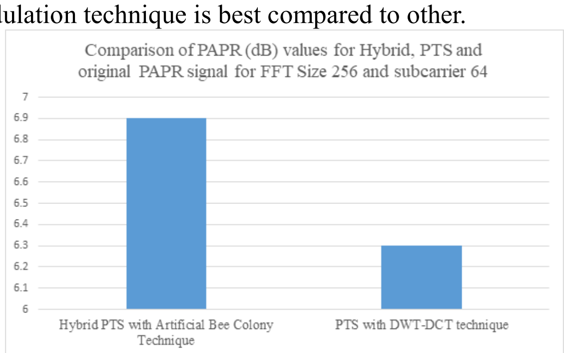


Figure 6 Comparison of PAPR (dB) values for Hybrid, PTS and original PAPR signal for FFT Size 256 and subcarrier 64

The proposed system is showing improvement of 13.23% peak average peak ratio (PAPR) than existing MIMO-OFDM based on PTS technique for FFT length 512 is shown in Figure 5.10.

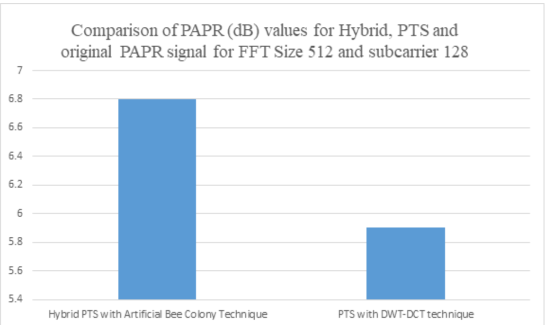


Figure 7 Comparison of PAPR (dB) values for Hybrid, PTS and original PAPR signal for FFT Size 512 and subcarrier 128

In this paper us implementation result and analysis of the proposed PTS with DWT and DCT technique based algorithm are discussed for the different modulation technique. This chapter also includes tabular and graphical representation of bit error rate (BER) and peak average peak ratio (PAPR) for different modulation technique for MIMO 2×2 wireless communication system. The proposed system is showing improvement of 8.6% peak average peak ratio (PAPR) than existing MIMO-OFDM based on PTS technique for FFT length 256 is shown in Figure.

7. CONCLUSION

Recently wireless communication is facing a lot of challenges and researches for achieving reasonable data rate without sacrificing the bandwidth efficiency. The principle deliberation of OFDM system has been to prevent spectral growth and improve the efficiency of the power amplifier at the transmitter side. The proposed system is showing improvement of 8.6% PAPR than existing MIMO-OFDM based on PTS technique for FFT length 256 and improvement of 13.23% PAPR than existing MIMO-OFDM based on PTS technique for FFT length 512.

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