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Constant modulus algorithm for PAPR reduction using PTS and clipping hybrid scheme in MIMO OFDM

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Abstract-Orthogonal frequency division multiplexing (OFDM) may be combined with antenna arrays at the transmitter and receiver side to increase the diversity gain and system competence on time variant along with the frequency selective channels, which results in a multiple-input multiple-output composition. The major drawback in case of MIMO-OFDM is its high value of Peak to Average Power Ratio (PAPR) which causes to frequency spread spectrum along with the in-band distortion. This is due to the presence of nonlinearity in the high power amplifiers. In this paper, a hybrid technique of Partial Transmit Sequence (PTS) and Clipping is proposed for PAPR reduction. Using the QAM modulated MIMO-OFDM systems and 22 number of antennas, it has been observed that the proposed technique has better performance for enhanced PAPR reduction.

I.INTRODUCTION

The Multi-Input Multi-Output orthogonal frequency division multiplexing (MIMO-OFDM) has achieved significant features as a promising technique for 4th generation (4G) wireless communication system. This MIMO-OFDM technique makes possible to use best interests of individual methods of MIMO and OFDM. The capacity and diversity gain of MIMO systems is added with the equalization simplicity of OFDM [1]. Link reliability and data rates are improved by using multiple transmit and receive antenna in MIMO system.

In this process, link reliability is achieved through both transmit and receive diversity leading to improved coverage [2] and high data rate multiplexing is obtained through spatial multiplexing, by transmitting independent data streams over various transmit antenna in parallel. OFDM (Orthogonal Frequency Division Multiplexing) is a form of digital modulation that divides a high data rate modulating stream placing them onto many slowly modulated narrowband close spaced subcarriers and in this way is less sensitive to frequency selective fading. In OFDM, the sub-carrier frequencies are chosen so that the sub-carriers are orthogonal to each other, meaning that cross-talk between the sub-channels is eliminated and intercarrier guard bands are not required. This greatly simplifies the design of both the transmitter and the receiver; unlike conventional FDM, a separate filter for each sub-channel is not required. OFDM has been adopted in the Wi-Fi arena where the standards like 802.11a, 802.11n, 802.11ac and more. It has also been chosen for the cellular telecommunications standard LTE/LTE-A and by other standards such as WiMAX and many more. OFDM is a frequency-division multiplexing (FDM) scheme used as a digital multi-carrier modulation method.

A large number of closely spaced orthogonal sub-carrier signals are used to carry data on several parallel data streams or channels. Each subcarrier is modulated with a conventional modulation scheme (such as quadrature amplitude modulation or phase shift keying) at a low symbol rate, maintaining total data rate similar to conventional single carrier modulation schemes in the same bandwidth. OFDM brings following improvements in wireless communication systems Computationally efficient: because of using FFT techniques to implement the modulation and demodulation process. Fading resistant: because of the parting the channel into narrowband flat-fading sub channels. Symbol recovery: because of the use of adequate channel coding and interleaving. Bandwidth efficient: because of having the advantages of mitigating ISI in frequency selective fading channels. Noise resistant: because of protection against co-channel interference and impulsive parasitic noise.

II. RELATED WORKS

In this paper we focus on PAPR reduction techniques based on nonlinear functions. Two well-known examples are clipping techniques which use a clipping function for PAPR reduction and filtering techniques which use at the transmitter side for PAPR reduction [2, 3]. However, since the OFDM signal consist s of a number of independently modulated subcarriers, it produces severer peak-to-average power ratio (PAPR) than single carrier signals. The large PAPR of the signal causes clipping when the signal is passed through the non-linear amplifier. Such clipping sproduces clipping noise that will result in performance degradation. In addition, clipping will also cause spectral re-growth in out-of-band which may cause interference to other systems.

So in the recent decade, numerous solutions and improved algorithms have already been proposed to reduce PAPR [4, 5]. The large PAPR will cause the error rate performance loss is the clipping noise generated by clipping when the signal is passed through a non-linear amplifier. The nonlinear distortion causes both in-band and out-of-band interference of signal. The in-band interference increases the BER of the received signal through warping of the signal constellation and inter modulation, while the out of-band interference causes adjacent channel interference through spectral spreading.

A.Conventional method

- Clipping causes in-band signal distortion, resulting in BER performance degradation.
- Clipping also causes out-of-band radiation, which imposes out-of-band interference signals to adjacent channels. Although the out-of-band signals caused by clipping can be reduced by filtering, it may affect high-frequency components of in-band signal (aliasing) when the clipping is performed with the Nyquist sampling rate in the discrete-time domain.
- However, if clipping is performed for the sufficiently oversampled OFDM signals (e.g., L 4) in the discrete-time domain before a low-pass filter (LPF) and the signal passes through a bandpass filter (BPF), the BER performance will be less degraded
- Filtering the clipped signal can reduce out-of-band radiation at the cost of peak regrowth. The signal after filtering operation may exceed the clipping level specified for the clipping operation.

B. OFDMA-basedWIMAX system

OFDMA-based WiMAX system employs a larger fast Fourier transform (FFT) size (2048 and 4096 subcarriers) that is further divided into sub-channels. The sub-channels are introduced to separate the data into logical streams in DL. Those streams may employ different modulations, coding schemes, and amplitude levels to address subscribers with different channel characteristics. The sub-channels also are used for multiple- access in UL. In practice, the subscribers are assigned to sub-channels through media access protocol (MAP) messages sent in downstream. OFDMA also enables smart antenna operations to be performed on vector-flat subcarriers based on smart antenna technologies that typically involve complex vector or matrix operations on signals due to the use of multiple antennas.

Several techniques have been proposed in order to reduce the PAPR. Some of these techniques are based on phase rotation and need Side Information (SI) to be transmitted to the receiver such as Partial Transmit Sequence (PTS)[6, 7, 8] and Selected Mapping (SLM). Some others do not need side information such as clipping and filtering [11, 12, 13], tone reservation, block coding, and ACE . In[8], authors have derived a simplified maximum likelihood (ML) decoder for SLM and PTS techniques that operates without side information to reduce the PAPR in orthogonal frequency-division multiplexing (OFDM) . In this paper, we analyze the combination of PTS method with MIMO-OFDM systems. For the proposed scheme, the PTS method is applied to each single transmit antenna. Based on the CCDF distribution of the MIMO-OFDM systems, the optimal parameters are chosen to have the lowest PAPR for each transmit antennas.

III. SYSTEM MODEL

In this MIMO-OFDM system, N subcarriers are transmitted from each antenna to make an OFDM block. These N subcarriers are a combination of useful subcarriers guarded by two zero energy bands. Again, useful subcarriers are divided into M resource blocks consisting of M subcarriers. Each resource block (RB) includes various pilot subcarriers to allow channel estimation at the receiver antenna. The transmit system model, compatible with the WiMAX standard [4] is designed in Fig. 1.

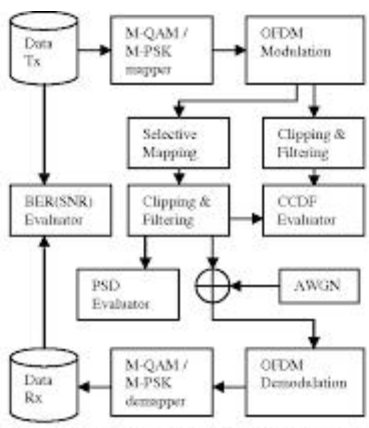


Figure 1. MATLAB model for the analysis of the hybrid PAPR reduction technique.

IV. METHODOLOGY

Orthogonal frequency division multiplexing is a form of multi carrier modulation technique with high spectral efficiency, robustness to channel fading, uniform average spectral density capacity of handling very strong echoes and less non- linear distortion. It has recently been used for both wireless and wired high rate digital data communications. Despite of its many advantages, like: high peak to average power ratio (PAPR) and frequency offset.

Advantages of Orthogonal Frequency Division Multiplexing, such as efficient spectrum utilization due to overlapping subcarriers, stem from the orthogonality principle between subcarriers which requires perfect timing and frequency synchronization.

Due to the fact that OFDM is an underlying technology of most modern wireless communication systems one can use and expand the project to study not only the OFDM system but also other wireless communication features. I developed synchronization mechanism based on a single master control counter and a state machine which can easily be expanded:

- To a larger number of OFDM subcarriers by adjusting a reference of the control signals to new master control counter values
- To include an additional feature by introducing an additional state in the state machine

  Development of synchronization mechanism involved implementation of algorithms which are commonly used in a digital transceiver design, such as:
- CORDIC algorithm of linear and circular type in both rotation and vectoring mode
- Fast-Fourier Transform
- Quadrature digital synthesis without ROM look-up tables

V. NUMERICAL RESULTS

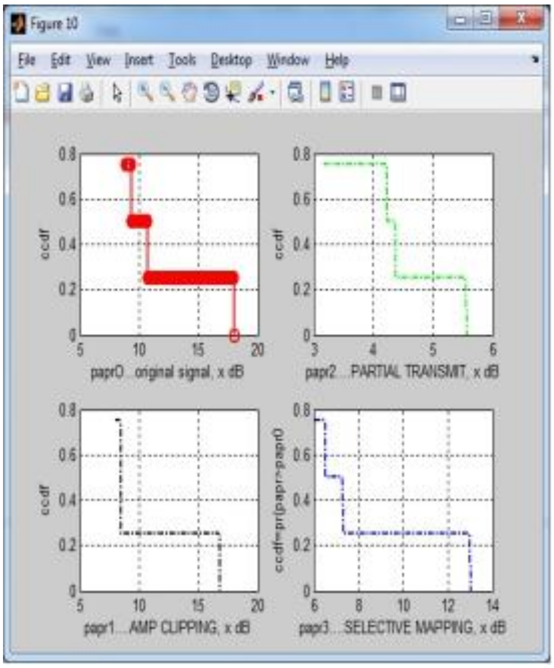
In WiMAX, 4 pilots and 32 data symbols are contained in one RB spans -N +O subcarriers over two OFDM symbols. There are a total of M = 120 RBs for a 20 MHz system. Using WiMAX standard, the proposed PAPR reduction technique is simulated for an OFDM block of N = 1024 size containing -N = 1024 data subcarriers with every band end. The MIMO transmit antenna numbers are indicated as

Parameters	Value
OFDM block size	**1024**
Number of transmitting antennas	**2**
Number of receiving antennas	**2**
Oversampling factor	**4**
PTS vector	**8**
Number of allowed phase vector	**4**

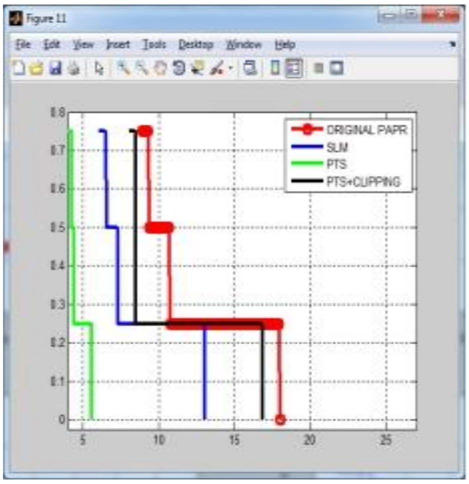
The simulation results using MATLAB 2013 are shown for 2×2 MIMO-OFDM system. The parameters which are used in simulations are described in Table.1.

The value of PAPR achieved by only PTS technique is compared with the value of PAPR obtained by hybrid technique of PTS and clipping. The curve of CCDF versus PAPR are shown for subcarriers N = 128, 512 and 1024.

Fig. 1. Shows the reduced PAPR obtained by only PTS by red colour curve and reduced PAPR obtained by the combined technique of PTS and clipping by green colour curve. These both curve show that reduced PAPR is much less as compared to the original PAPR. From the graph, it is noticed that the PAPR is 11.2 dB of original OFDM with CCDF of +H0D



Similar PAPR reduction results are shown in Fig.10 for subcarriers N = 512 and in Fig.2 for subcarriers N = 1024.



VI. CONCLUSION

OFDM is a frequency-division multiplexing (FDM) scheme used as a digital multi-carrier modulation method. A large number of closely spaced orthogonal sub-carrier signals are used to carry data on several parallel data streams or channels. Each subcarrier is modulated with a conventional modulation scheme (such as quadrature amplitude modulation or phase shift keying) at a low symbol rate, maintaining total data rate similar to conventional single carrier modulation schemes in the same bandwidth

In proposed system providing high-data-rate offerings over wireless channels, Multiple Input Multiple Output Orthogonal Frequency Division Multiplexing (MIMO-OFDM) gadget had been proposed in the latest beyond. This gadget affords the advantages of space-time coding and OFDM when its miles mixed with area time coding. The MIMO-OFDM gadget also suffers from the excessive peak-to-average power ratio (PAPR) trouble. This happens due to the inter-symbol interference between the subcarriers of the communiqué system. Through the use of clipping and filtering the entire look for the number of sub-blocks and the rotation elements should be done, if you want to achieve top-rated PAPR discount. As the number of sub-blocks and rotation factors will increase, PAPR reduction improves.

VII. FUTURE ENHANCEMENT

- In future, method is doing very well in comparison to the present approach in phrases of PAPR reduction.
- The range of iteration increases i.e. a number of clipping and filtering increases PAPR reduces step by step.
- The PAPR decreases because the number of clip and filtering is increased from one to energy levels.
- That is due to the fact the clipping is observed by using filtering to reduce out of band strength and energy level.

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