A Novel PAPR Reduction Scheme Utilizing Modified Filtered Selective Mapping Approach

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Abstract*-consideration of more efficient and robust OFDM technology became a viable option for high data rate multimedia implementations. An OFDM is known as a multi-carrier or discrete multi-tone modulation scheme, uses different sub-bearers to transport data from one user to another. In the process of data transmission, signal after modulation is amplified in transmitter. This demands transmitter to operate in linear region, conversely, amplitude of data should lie in linear range of transmitter power amplifier. Also, communication system's performance heavily depends on the faithful amplification of transmitter power amplifier. The transmitter power amplifiers are high power amplifier used to transmit the signal. In a time domain system the ratio of peak to average power is an important parameter of the communication framework using OFDM signaling. The PAPR of OFDM transmitter should be minimized effectively. To overcome the computational complexity and bandwidth efficiency issue an effective technique which significantly enhanced the performance of the OFDM system in addition with selective mapping(SLM) is used , here an average filtering is used which is linear in nature and does not increase the complexity of the system. From simulation results, it is clear that the proposed approach is making future technology more robust for OFDM systems.

***Index Terms*: Orthogonal frequency division multiplexing (OFDM), partial transmit sequence (PTS), peak-to-average power ratio (PAPR), selective mapping (SLM), and tone reservation (TR).**

I. INTRODUCTION

OFDM is a form of signal modulation that divides a high data rate modulating stream to many slowly modulated narrowband close-spaced sub-carriers. In this way narrowband sub-channels, carried by close-spaced sub-carrier, becomes less sensitive to frequency selective fading. In some respects, OFDM is similar to conventional frequency-division multiplexing (FDM). The difference lies in the process in which individual sub-carriers are modulated and demodulated. Priority is also given to minimize the interference and crosstalk among the channels and symbols comprising the data stream. Generally all channels are handled together and individual channels are never handled separately.

OFDM transmission technology is an effective implementation of a multicarrier modulation principle where a high-speed serial data stream is split into multiple parallel low-rate streams, each modulating a different sub-carrier. This principle changes the frequency selective broadband channel to a multitude of flat narrowband channels. Additionally, this enables the channel to be robust against multi-path propagation. Furthermore, OFDM can be easily combined with multiple antenna techniques leading to Multiple Input Multiple Output (MIMO). Due to the excellent performance, high flexibility, and simple implementation, OFDM has been the basis of a number of recent communication standards. Since the network's interference becomes a driving factor for system performance, hence, it is a hot research topic.

After giving a brief introduction of OFDM system, a block diagram which briefly describes the system details has been shown in Fig 1.1.

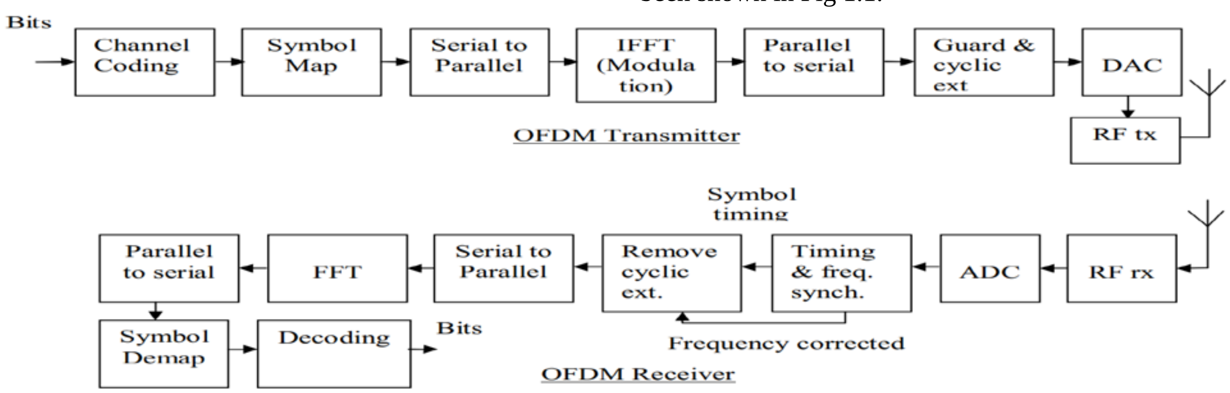

Fig. 1.1 OFDM System Block Diagram.

At the transmitter, the user information bit sequence is first subjected to channel encoding to reduce the probability of error at the receiver due to the channel effects. Usually, convolution encoding is preferred. Then the bits are mapped to symbols of either 16-QAM or QPSK. The symbol sequence is converted to parallel format and IFFT (OFDM modulation) is applied and the sequence is once again converted to the serial format. Guard time is provided between the OFDM symbols and the guard time is filled with the cyclic extension of the OFDM symbol. Windowing is applied to the OFDM symbols to make the fall-off rate of the spectrum steeper. The resulting sequence is converted to an analog signal using a DAC and passed on to the RF modulation stage. The resulting RF modulated signal is, then, transmitted to the receiver using the transmit antennas. Here, directional beam-forming can be achieved using antenna array, which allows spectrum reuse by providing spatial diversity.

The use of a large number of sub-carriers in OFDM system introduces a high PAPR. High PAPR limits the operation of transmitter power amplifier and causes saturation of receiver amplifier. The ratio of peak power to the average power of a transmitter should be maintained low for faithful amplification. Furthermore, the reduction in PAPR results in a system that can either transmit more bits per second with the same hardware, or transmit the same bits per second with lower-power hardware. This results in lower electricity costs or less expensive hardware, or both. To mitigate this effect a novel PAPR reduction scheme utilizing modified filtered selective mapping approach has been proposed in this work.

II. SELECTIVE MAPPING APPROACH

This is an effective and distortion less technique used for the PAPR reduction in OFDM. The name of this technique indicates that one sequence has to be selected out of a number of sequences. According to the concept of discrete time OFDM transmission, we should make a data block considering N number of symbols from the constellation plot, where N is the number of subcarriers to be used. Then using that data block U number of independent candidate vectors are to be generated with the multiplication of independent phase vectors.

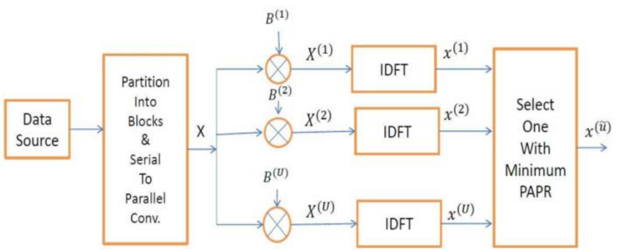

Fig. 2.1 Block Diagram of SLM.

Let us consider X is the data block with X (k) as the mapped sub symbol (i.e. the symbol from the constellation) where k = {0, 1, 2, ...N − 1}. Let the u phase vector be denoted as B, where u = {1, 2, ...U }. The u candidate vector that is generated by the multiplication of data block with the phase vector is denoted as $X^{(u)}$.

The figure 2.1 provides description about the transmitter side of the SLM technique. This selected OFDM signal at the transmitter side has to be detected at the receiver. So the receiver must have the information about the perfect phase vector that has been multiplied to generate that selected OFDM signal. Hence to fulfill the requirement of the receiver some side information (SI) has to be transmitted along with the selected OFDM signal. This SI index is generally transmitted as a set of ⌈log2 U ⌉ bits. For the efficient transmission of these extra bits, channel coding technique is required. If any SI index cannot be detected perfectly, then that total recovered transmitted block will be in error. So we should follow a new SLM technique which avoids the sending of SI index.

III. PROPOSED METHODOLOGY

A modified SLM approach with low computational complexity, multifaceted nature is proposed. Fig. 3.1 shows block diagram of proposed methodology.

The application of proposed Selected Mapping technique has been done on the transmit diversity case especially for the case of one transmitting antenna and one receiving antenna. So to transmit a signal from an antenna, we should follow some transmit diversity technique.

The strategy is to apply the SLM plan with average filtering in the existing system. In this plan, the signal is first filtered with average filtering and then selective mapping is applied which significantly enhances the performance of the system i.e. reduction in PAPR. In light of the proposed SLM with filtering plan, the computational intricacy is lessened, contrasted with the expected SLM plan, on the grounds that average filtering is linear in nature and does not add the complexity in the system.

Basic principle behind this method is to change the phase of each successive symbol inside the OFDM frame. For N number of sub-carriers, there are N symbols denoted as n = 0, 1, 2, . . . , N − 1 OFDM symbols. First OFDM symbol is to be transmitted as it is. From second symbol onwards, each odd OFDM symbol is multiplied by +1 and each even OFDM symbol is multiplied by -1. The second OFDM symbol to be transmitted is the sum of first two OFDM symbols (after multiplication by either +1 or -1). Similarly, the process goes on for N number symbols.

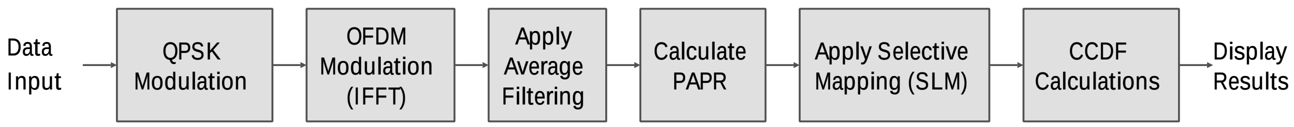

Fig. 3.1 Block Diagram of Proposed Methodology.

The flow chart shown in Fig. 3.2 explains the step by step execution of proposed methodology. The first step is to create an environment similar to practical situations for communication and for this we need to declare some variables. After variable initialization the data stream is generated which helps to calculate various parameters.

Separate the data stream in-phase and out-phase, then transform the signal to time domain so that it can be transmitted through channel. After that, apply average filtering, then calculate mean power and average power, and then apply selective mapping for calculations of PAPR.

Compare the results of SLM and SLM with average filtering. We can observe from the results that the proposed methodology is giving better results than previous methods.

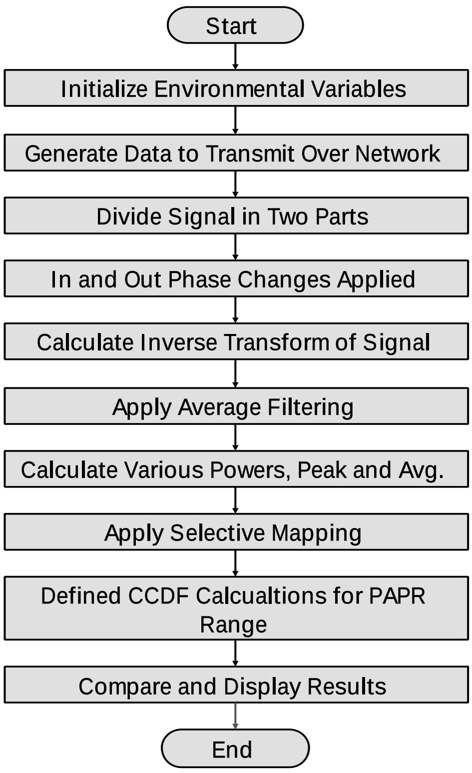

Fig. 3.2 Flow Chart of Proposed Methodology.

IV. SIMULATION RESULTS

MATLAB (R2011a) is used to observe the performance of the OFDM system . For simulation, the system is designed with the help of variables, which creates a practical environment for calculating results in various conditions.

For simulation studies, the QPSK scheme has been used. According to the proposed approach, the same phase sequence will be multiplied with the two different signals. Then the IFFT of these signals for antenna is taken and the OFDM signal with minimum PAPR is selected. Then to find out the Complementary Cumulative Distribution Function plot for the performance analysis of PAPR, the maximum PAPR value will be considered out of the two different minimum PAPR value.

The outcomes observed on MATLAB software simulation tool refers to the examination of complementary cumulative distribution function (CCDF) versus peak to average power ratio (PAPR). In the proposed methodology, it is reported that a selective mapping (SLM) approach along with average filtering gives better results than only using SLM. Simulation results also show the comparison with theoretical values of the PAPR. System simulations have been performed with different FFT sizes and OFDM symbols as the results change with changes in FFT size and symbols.

Fig. 4.1 shows the performance of the system for theoretical, SLM alone and SLM along with average filtering, with 64 carriers and 1000 symbols. From the results is it clear that the proposed methodology gives better results than previous methods.

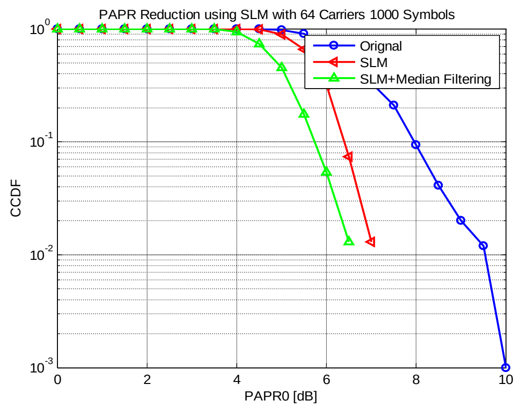

Fig. 4.1 CCDF vs PAPR with 64 carriers and 1000 symbols.

Similarly Fig. 4.2 shows the performance of the system for theoretical, SLM alone and SLM along with average filtering, with 64 carriers and 5000 symbols. From the results is it clear that the proposed methodology gives better results than previous methods.

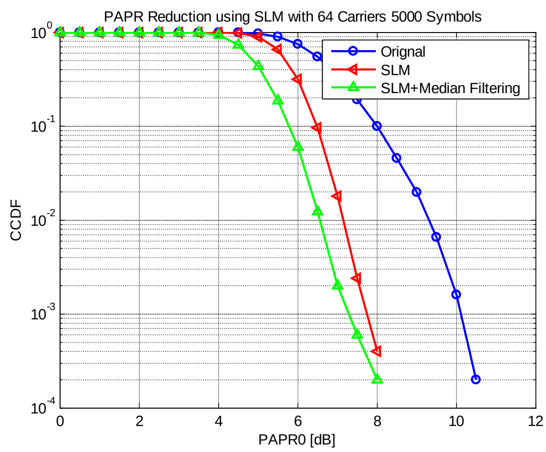

Fig. 4.2 CCDF vs. PAPR with 64 carriers and 5000 symbols.

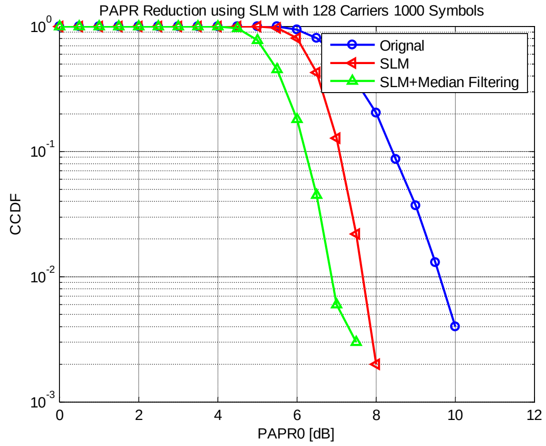

Fig. 4.3 CCDF vs. PAPR with 64 carriers and 5000 symbols.

Fig. 4.3 shows the performance of the system for theoretical, SLM alone and SLM along with average filtering, with 128 carriers and 1000 symbols. From the results is it clear that the proposed methodology gives better results than previous methods.

V. CONCLUSIONS AND FUTURE SCOPE

The high PAPR is acknowledged to be one of the real draw-backs of OFDM frameworks, on the grounds that the huge indicator fluctuation offers ascent to the low average power. In this paper, we proposed PAPR decrease plans using SLM with average filtering for accomplishing a low computational multifaceted nature. Despite the fact that numerous PAPR reduction schemes have been created, none of them satisfies business necessities or has been embraced as a standard for remote correspondence frameworks. However, the modified PAPR diminishment plans with low computational intricacy might be connected to high information rate OFDM frameworks. Future studies on reducing PAPR may incorporate a combination of diversity.

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