Hybrid Method for PAPR Reduction in SFBC OFDM Systems

Balla Bhavani[1] and Thota Sravanti[2]
[1]M.Tech Student, CVR College of Engineering/ECE Department, Hyderabad, India
Email: bhavani333balla@gmail.com
[2]Asst. Professor, CVR College of Engineering/ECE Department, Hyderabad, India
Email: sravanti23@gmail.com

Abstract*: Orthogonal Frequency Division Multiplexing is an important technique in wireless communication systems. Multiple Input Multiple Output (MIMO)-OFDM with Space Frequency Block Code (SFBC) is a smart technique used due to its capability to support elevated data rates, large capacity and robust to multipath fading. A high peak-to-average-power ratio is one of the disadvantages of OFDM. Many PAPR Reduction techniques have been introduced like Companding and Selective mapping (SLM) techniques. In proposed method, the optimum PAPR can be achieved than above methods by a new hybrid method i.e., combining *SLM* and *Companding techniques.

***Index Terms:* Orthogonal Frequency Division Multiplexing, MIMO-OFDM, SFBC, SLM, Companding**

I. Introduction To Mimo-Ofdm

The data which is to be communicated wirelessly has been transferred by analog domain in the earlier days which has been mostly done by digital domain in now a days. To make the process easier, multiple sub-carriers are implemented in the system instead of single carrier.

A. OFDM

According to the challenge of this generation, the need and priority of elevated speed communication evolves into various multicarrier modulation techniques, among these techniques OFDM technique is one. OFDM is the frequency-division multiplexing (FDM) system used as a multi-carrier tone technique. To transmit the information, the huge amount of narrowly spaced orthogonal sub-carriers is used and the data is alienated as similar streams of channels. The sub-carriers are modulated with keying techniques (such as QPSK) at a subtle symbol rate in the same bandwidth. *Applications:* Asymmetric Digital Subscriber Line, Digital Audio Video broadcast TV systems etc.,. *Advantages:* Saving of Bandwidth, Protection against Inter-Symbol-Interference, Easy Equalization etc.,. *Disadvantages:* Synchronization and High peak-to-average-power ratio (PAPR) [1] [2].

B. MIMO-OFDM

OFDM system plus MIMO have the ability to transmit huge data. In MIMO system the channel capacity can be enhanced by transmitting the data from several numbers of transmitters side to many numbers of receivers side are efficiently combined. The class of wireless describes three basic parameters namely the transmission rate, the range and reliability. Due to these parameters, this technology stands as major attracting technique in wireless communications and becomes an significant part of modern wireless communication principles such as 3GPP long term evolution, 4G, IEEE 802.11n (Wi-Fi) [3]. According to broadband wireless MIMO-OFDM communication systems initial field tests, it has been exposed that the better coverage area, reliability and capacity are reachable with the support of MIMO techniques.

The foremost techniques concerned in MIMO system are: *Pre-coding* is the ray forming method which is generally implemented at the transmitter part, requires precise information of channel state information (CSI). *Spatial multiplexing* method, the lofty information signal is divided into low data streams and the streams are transmitted with the aid of diverse transmit antennas which are having the similar frequency. *Diversity coding* techniques are used at the transmitter with no channel knowledge. In diversity coding, the single data flow is transmitted with a coding procedure called space-frequency coding.

C. Alamouti Space-Frequency Diversity

Space - Frequency codes are engaged to make sure that the signals transmitted in different antennas are orthogonal to each other so that it is trouble free for the receiver to discern one from another. For Line-of-sight (LOS) contact among two stations dual antenna polarization is used to make certain one robust path. To achieve the benefits offered by MIMO systems, *Alamouti Scheme* can be performed [4]. It is the easy way of acquiring transmit diversity in the task of two transmit antennas (also known as transmission/reception scheme) is easy to implement.

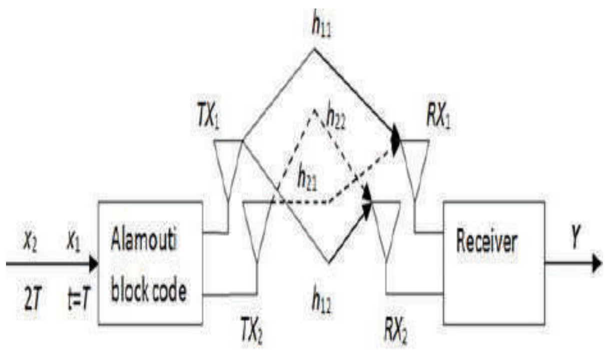

Figure 1. Alamouti Scheme

D. PAPR

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The peak to average power ratio of the transmitted signal [4] is:

$$PAPR(x[n]) = \max_{0\le n\le N-1} \frac{|x[n]|^2}{E[|x[n]|^2]}. \quad (1)$$

Expressing in decibles: *PAPRdB = 10log10 (PAPR)*

E. CDF

The Cumulative Distribution Function (CDF) is used to measure the efficiency and Complementary CDF (CCDF) and is used to compute the probability of any PAPR technique.

F. PAPR Reduction Techniques

PAPR reduction techniques are dependent on various factors and differ according to the needs of the system. Many factors are in use before adopting a PAPR reduction technique [5] like capacity, loss in data rate, increase in power in transmit signal, complexity of computation and bit-error rate performance.

Clipping and Filtering: In this procedure, the threshold value of the amplitude is fixed and the amplitude of the sub-carrier over the threshold is clipped or it is filtered to produce a minimum PAPR[6].

Companding Transform (CT): This transform can be designed to meet excellent transaction between PAPR reduction and BER performance with two inflexion points in order to increase the flexibility of companding [7].

Selective Mapping (SLM): In this process, the representation of information in a group of ample dissimilar information blocks that are similar as the unique data blocks which are selected. Thus, it is suitable for transmission if the selection of data blocks have low PAPR value [8] [9].

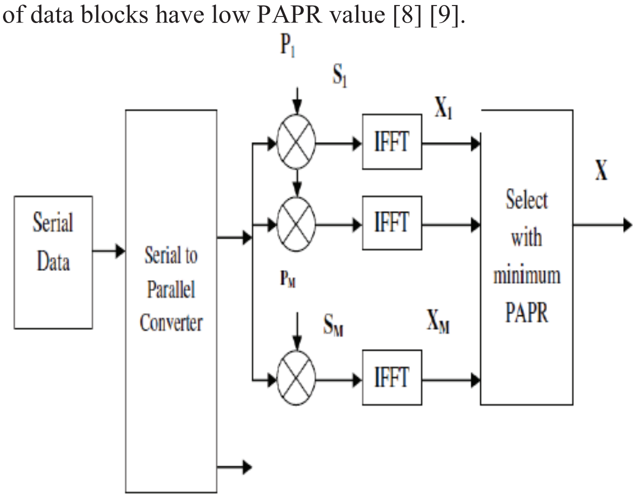

Figure 2. Selective-Mapping Technique

Partial Transmit Sequence (PTS): The information which is to be sent in the signal as a whole is covered by the transmission of only part of the data of varying sub-carrier is called Partial Transmit Sequence Technique [10].

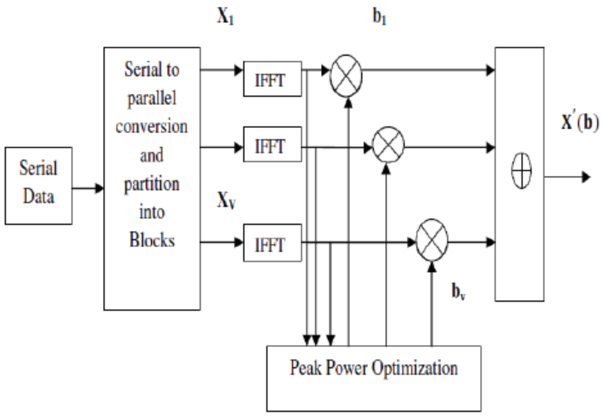

Figure 3. Block Diagram of Partial Transmit Sequence

II. Proposed Hybrid Method

A. Hybrid Method

The hybrid method comprises of merging the MIMO-OFDM method with SLM method and Companding Mu-law technique. The method is as follows:

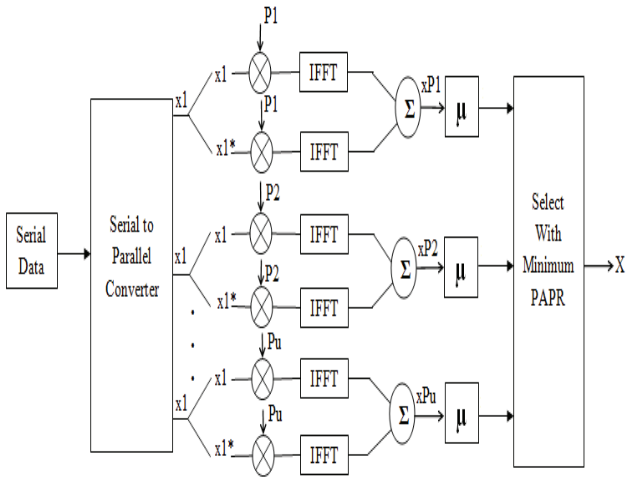

Figure 4. Block Diagram of Hybrid Method

Companding Mu-Law Technique: - It has little complexity despite of the numeral subcarriers in an OFDM signal. In OFDM system, signal will be kept unchanged by taking the suitable companding factors in Companding process [11].

The Mu-law:

$$y(x) = V\frac{\log(1+\mu\frac{|x|}{V})}{\log(1+\mu)}sgn(x) \quad (2)$$

The original OFDM symbol is partitioned into sub-blocks and are computed with phase rotation sequences, then each OFDM symbol is companded using Mu-law technique. By the selection block, the comparatively lowest PAPR can be obtained [12].

The program procedure will be written in the flowchart as follows:

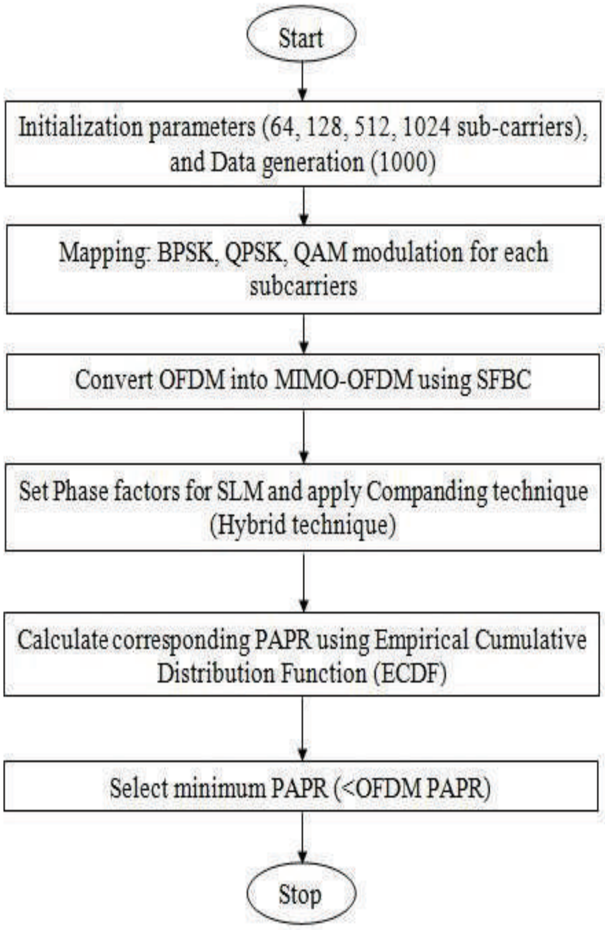

Figure 5. Flow Chart of Hybrid Method

B. Simulation Results

SLM technique is applied to the sub blocks of the input information, and modulated by QPSK technique and phase factors (±1, ±j) are directly transmitted to the receiver through sub block. Complementary Cumulative Distribution Function is used for the performance evolution and it is evaluated for different number of sub-carriers such as 64, 128. The oversampling factor is greater than 4 which is used to increase the resolution of discrete time OFDM signal. The implementation of PAPR reduction in SFBC MIMO OFDM systems has been done with 64, 128 symbols of OFDM generation bits and oversampling is applied to all OFDM symbols [13] [14].

The Figure 6, 7 show the simulation of PAPR reduction of symbol length in MIMO-OFDM by using SLM technique.

The PAPR value of MIMO-SLM method for 1000 symbols when the number of sub-carriers = 64 is 6.8dB.

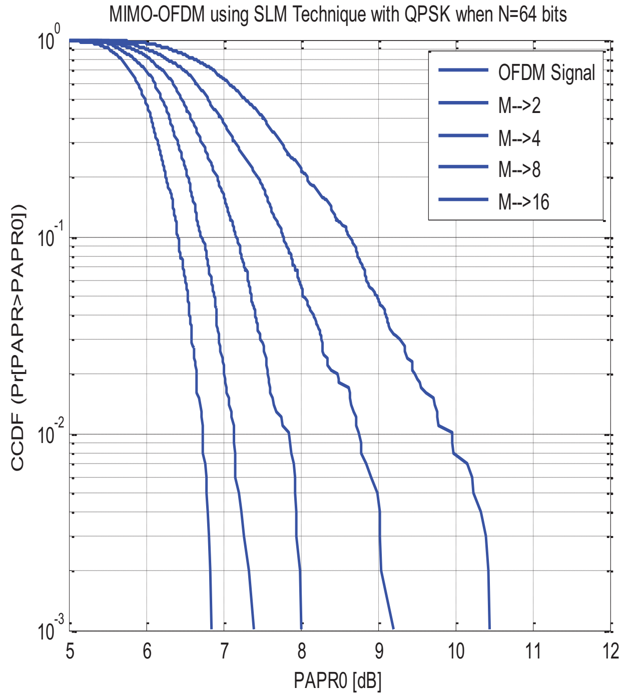

Figure 6. Performance Analysis of the MIMO-SLM Method with QPSK Modulation With N = 64 Bits

The PAPR value of MIMO-SLM method for 1000 symbols when the number of sub-carriers = 128 is 7.6dB.

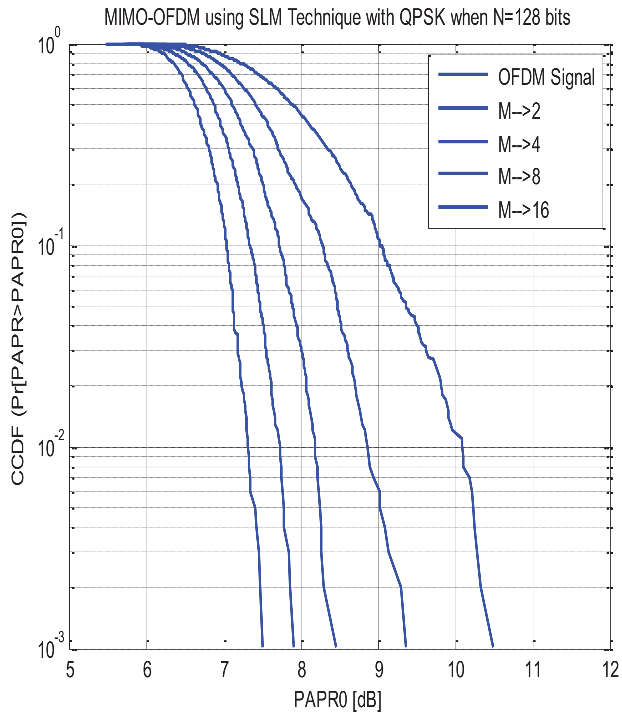

Figure 7. Performance Analysis of the MIMO-SLM Method with QPSK Modulation with N = 128 Bits

The Figure 8, 9 show the simulation of PAPR reduction of symbol length in MIMO-OFDM by using the combination of SLM and Companding Mu-law technique.

The PAPR value of the proposed Hybrid method for 1000 symbols when the number of sub-carriers = 64 is reduced from 6.8dB to 4.9dB.

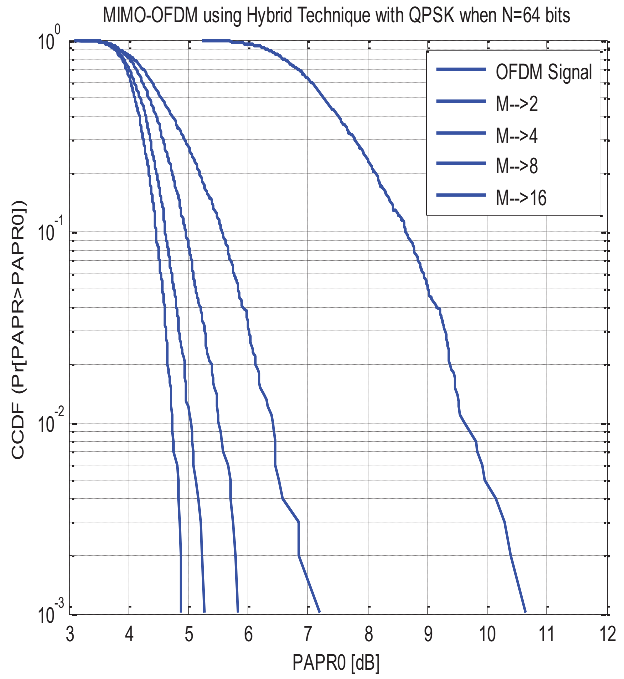

Figure 8. Performance Analysis of the Proposed Hybrid Method with QPSK Modulation With N = 64 Bits

The PAPR value of the proposed Hybrid method for 1000 symbols when the number of sub-carriers = 128 is reduced from 7.6dB to 5.9dB.

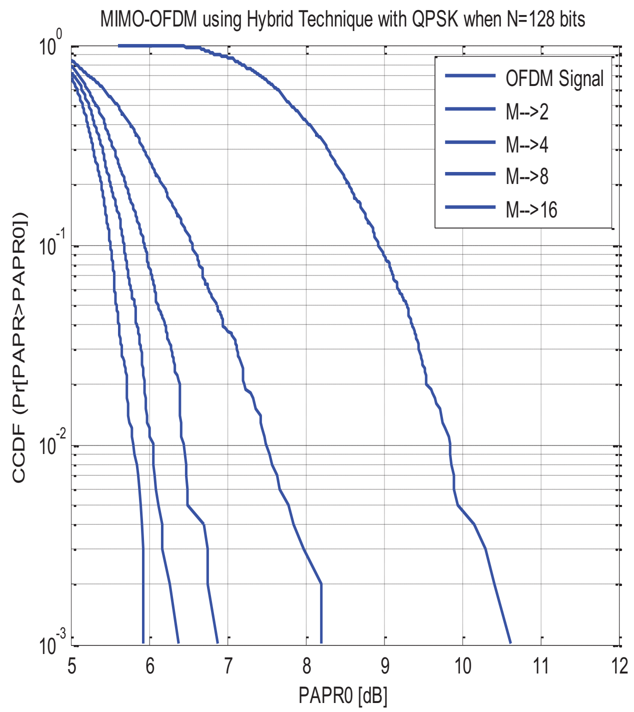

Figure 9. Performance Analysis of the Proposed Hybrid Method with QPSK Modulation With N = 128 Bits

III. Conclusions

For both wired and wireless communications high data rate transmission, OFDM is a spectrally efficient multi-carrier modulation method. MIMO-OFDM suffers with high PAPR and many reduction techniques have been proposed [15]. By comparing these things, the proposed method which is hybrid method has been implemented to reduce PAPR. For N=64, the PAPR of MIMO-OFDM using SLM is 9.2dB. Hence MIMO-OFDM using SLM technique reduced PAPR of about 1dB. In the projected technique the PAPR for N=64 is 7.0dB, thus the PAPR is diminished to 2.2dB than MIMO-OFDM with SLM. In future, the hybrid method can be designed by combining MIMO-OFDM with SLM and any other Companding technique like A-law, Exponential law and Tangent law. Hence hybrid method is a good technique for reducing PAPR and this evaluation can be considered as a valuable research resources.

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