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Performance Improvement in MIMO-OFDM System by PAPR Reduction

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Abstract

This paper proposes an advanced MIMO-OFDM reconfigurable architecture along with companding transform. The reconfigurable architecture uses switching algorithm between MIMO diversity and special multiplexing which allows selecting the MIMO configuration and improves the BER. The major drawback of orthogonal frequency division multiplexing (OFDM) system is peak to average power ratio (PAPR). Many techniques were developed to reduce PAPR. Considering all available PAPR reduction techniques, companding transform is attractive technique for its simplicity. This paper put forward the comparison of two techniques namely exponential companding and nonlinear companding. In this paper evaluation of performance is shown in terms of bit error rate and peak to average power ratio.
Keywords: MIMO-OFDM, PAPR reduction, switching algorithm, exponential companding, nonlinear companding

I. INTRODUCTION

Today's wireless communication systems demand high rate and spectral potency with increased reliability. Multiple-Input Multiple-Output (MIMO) systems are common techniques to realize these goals [1]. The improved diversity order is feasible through transmit diversity theme (e.g., frame of reference block code, STBC) [2]. Different ways like square measure link adaptation techniques, wherever transmission parameters like modulation and cryptography square measure dynamically tailored to the varied channel condition [3]. A typical link adaptation technique is reconciling modulation during which Associate in nursing adequate modulation level is chosen by suggests that of the present ratio (SNR). In recent years, vital attention has been created to MIMO (Multiple Input Multiple Output) technologies that provide high spectral potency and strength against attenuation and interference [1] additionally, victimization OFDM (orthogonal frequency division multiplexing) with MIMO permits simplifying the equalization at the receiver [2]. MIMO-OFDM is presently being thought of for variety of developing wireless standards like IEEE 802.16e-2005 and has been recommended to be used in on the far side 3G (B3G) and 4G wireless communications. Moreover, reconciling algorithms in MIMO systems wherever transmitter blocs' specifications square measure adjusted in step with the channel state are the topic of the many analysis teams [3], [4]. The two common MIMO techniques to use in an adaptation context are the MIMO diversity (MD) and the Spatial Multiplexing (SM) [5]. Although the primary technique uses 2 or additional antennas within the transmitter and therefore the receiver facet to enhance the wireless link quality, the other permits sending severally and one by one encoded knowledge signals from every of the multiple transmit antennas to enhance the link capability. Moreover, The SDR answer provides a high flexibility to adapt the system to satisfy totally different wants of various customers. The utilization of software package to make and management most of the functions in base stations and client premise instrumentation permits for brand new levels of flexibility and low-priced system upgrades [6]. For instance, a 2x2 MIMO shown in Figure 1 can have higher output.

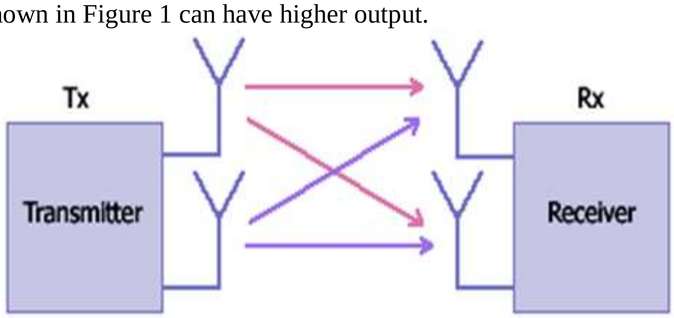

Fig. 1: Multiple Input Multiple Outputs System.

Generally there square measure 3 classes of MIMO Techniques. The primary aims to enhance the ability potency by increasing spatial diversity. Such techniques embody delay diversity, reference frame block codes (STBC) and reference frame trellis codes (STTC). The second category uses a bedded approach to extend capability. One widespread example of such a system is V-BLAST instructed by Foschini et al. wherever full spatial diversity is sometimes not achieved. Finally, the third kind exploits the data of channel at the transmitter. It decomposes the channel constant matrix mistreatment Singular price Decomposition (SVD) and uses these rotten unitary matrices as pre and post filters at the transmitter and therefore the receiver to attain close to capability.

II. LITERATURE SURVEY

This section introduces review of different methods related to topic.

The multiple input multiple-output OFDM wireless communication system test results show good performance with increase in capacity, coverage, and reliability over SISO, MISO, or SIMO communication systems [1]. The link adaptation (LA) algorithm applied to a MIMO-OFDM physical layer (PHY) attempts to maximize throughput [3]. This algorithm is proposed for downlink performance analysis. The new architecture for MIMO [5], the key to this architecture was the use of processing devices with additional capability to support processing requirements of the MIMO algorithms, and the use of a switched-fabric interconnects [5].

The new method of dynamic rate-adaptive MIMO mode switching scheme shows better ASE performance than the static MIMO mode switching scheme with adaptive modulation [4]. In the conventional static mode, the MIMO mode changes depending on the average SNR instead of the instantaneous channel condition. An advanced OFDM-MIMO reconfigurable architecture uses an adaptive switching algorithm between diversity and spatial multiplexing [6]. The reconfigurable architecture allows selecting the MIMO configuration and improves the BER. Author S. M. Alamouti presented a simple two-branch transmit diversity scheme. Using two transmit antennas and one receive antenna the scheme provides the same diversity order as maximal-ratio receiver combining (MRRC) with one transmit antenna, and two receive antennas. It is also shown that the scheme may easily be generalized to two transmit antennas and M receive antennas to provide a diversity order of 2M.

An extended narrowband MIMO-SM schemes to UWB systems shown that nonlinear detection techniques significantly exceed linear receivers [8]. They observed that with an appropriate detection scheme and low sub channel correlation UWB MIMO systems not only provide higher data-rates but also improved diversity orders.

Authors in [9] investigate the performance of a previously published hybrid channel model, where a standard ray-tracing model is combined with a statistical approach for simulation of compressed multipath components. They conclude that the hybrid method outperforms the conventional ray-tracing model, delivering practical performance estimates.

A complete adaptive SVD algorithm along with reconfigurable architecture design was proposed [10]. From the experimental results, they observed that SVD engine achieves a higher throughput rate than other related works and it is very suitable for the high-throughput MIMO-OFDM applications.

III. PROPOSED APPROACH FRAMEWORK AND DESIGN

A. Problem Definition

Recent MIMO systems needs the adaptive reconfiguration architecture and based on user and network conditions so that performance of wireless communication increases. Recently many advances done in MIMO reconfiguration, however still there is no work done for 4G networks. This is one of the vital research problems.

MIMO OFDM modulation scheme reconfigurable architecture to the main purpose behind the channel State, which gives a practical cognitive radio are adjusted according to the strategy. Demmel condition number criteria based on an indicator bit optimized exchange between MIMO transmitter and receiver by selecting the configuration and whole system allows you to improve the performance.

B. Proposed Approach

The basic goal was to enable co-existence with current products and provide the basis for seamless upgradability to beyond 3G Wireless systems through the use of Software Defined Radio (SDR) and Adaptive Antenna Systems (AAS). The selection criterion, which is based on channel properties, uses the Demmel Condition number to choose the appropriate technique.

C. Proposed Architecture

The main aims behind presenting the reconfigurable architecture of OFDM-MIMO the modulation scheme are adjusted according to the channel state, which gives a practical cognitive radio strategy. Based on the Demmel condition number criterion, an indicator bit exchange between the transmitter and the receiver allows selecting the adapted MIMO configuration and improving the whole system performances.

The two common MIMO techniques to use in an adaptation context are the MIMO diversity (MD) and the Spatial Multiplexing (SM) which needs to switched in order to have efficient BER performances.

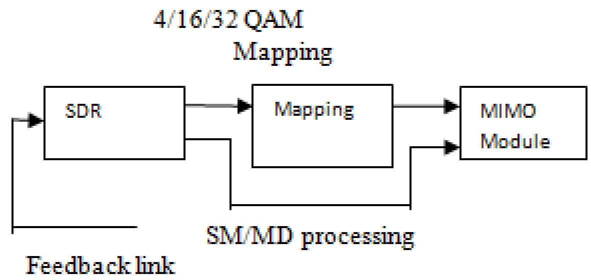

Fig. 2: Transmitter reconfigurable architecture

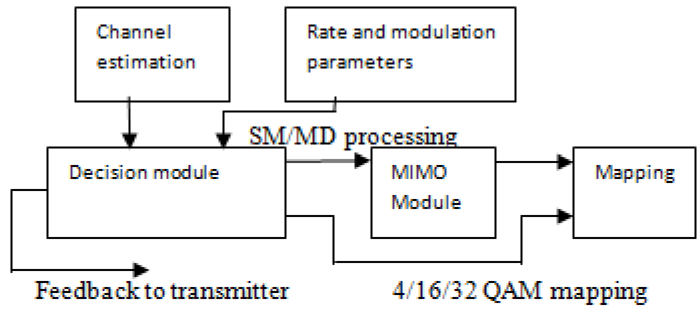

Fig. 3: Receiver reconfigurable architecture

1) Stage 1: Transmitter Reconfigurable Design:

If the indicator bit is set, BPSK/4-QAM modulation and SM technique are employed. Else, 16QAM/ 32QAM modulation and MIMO Diversity are chosen as the transmission parameters at the end of OFDM-MIMO Transmitter, this shown in Fig. 2.

2) Stage 2: Receiver Re-configurability Design

The receiver reconfigurability design performs two tasks.

- First, according to information provided by the channel estimation block, the adaptation module will compute the Demmel Condition number and prepare a decision vector.
- Then the demodulation and spatial processing stages are configured to support the selected communication scheme.

3) Stage 3: PAPR Reduction Based on Nonlinear Companding Scheme.

This section proposes a new companding technique that can effectively reduce the PAPR of transmitted OFDM signals by transforming the statistics of the amplitudes of these signals into uniform distribution. The new scheme also has the advantage of maintaining a constant average power level in the nonlinear commanding operation. The strict linearity requirements on HPA can then be partially relieved.

IV. RESULT ANALYSIS

Input Configurations for designing the proposed OFDM reconfiguration model the used parameters are mentioned below.

1) IFFT/FFT size = 64
2) no of data subcarriers = 48
3) pilot subcarriers = 4 (decide whether to include or not)
4) no of subcarriers, total = 52
5) bandwidth = 20 MHz
6) subcarrier spacing = 0.3125 MHz
7) IFFT/FFT period = 3.2 microsec
8) cyclic prefix duration = 0.8 microsec
9) total OFDM symbol duration = 4 microsec
10) ModulationTechnique=QPSK/BPSK/16-QAM/64-QAM

Hardware and Software Configuration is described as below

A. *Hardware Requirements*

Processor	:	Pentium IV 2.6 GHz
Ram	:	512 MB DD RAM
Monitor	:	15” COLOR
Hard Disk	:	20 GB

B. Software Requirements

Front End : Matlab
IDE Used : Matlab 2011
Operating System : Windows 7

Following fig. 4 presents the input model which is designed using MATLAB Simulink. In this model shows that proposed switching function and transmitter as well as receiver functionalities are depicted.

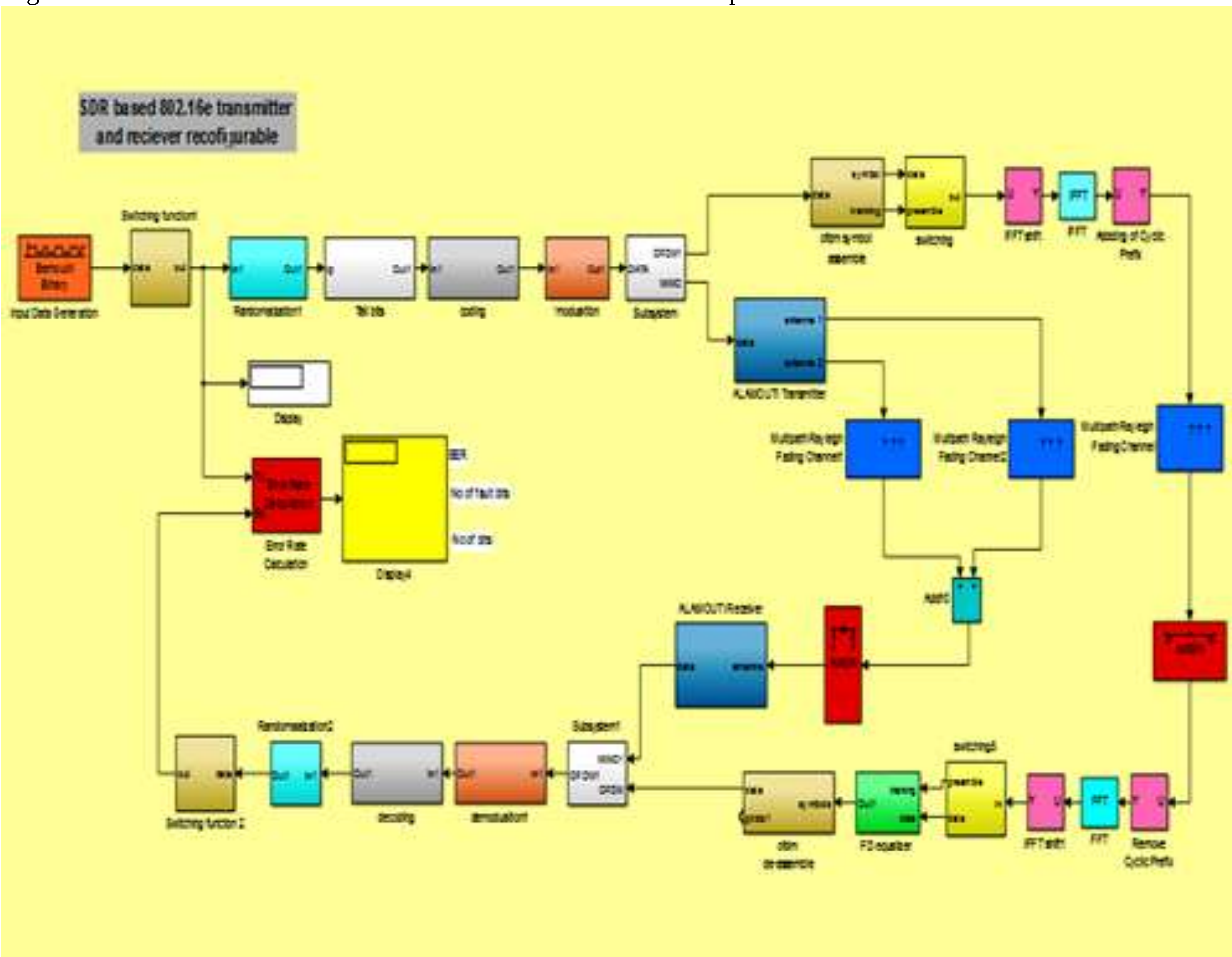

Fig. 4: Proposed OFDM transmitter and receiver reconfigurable designed model

C. Results Obtained

1) For QPSK modulation technique

Table -1
Performance Analysis of QPSK

Modulation	SNR	SM				MD		
		Original	EC	NLC	% Improvement for SM	EC	NLC	% Improvement for MD
QPSK	12.5	8.274	6.414	5.833	9.06	7.47	6.403	14.32
QPSK	13.5	8.274	6.261	5.865	6.32	6.31	6.11	3.11
QPSK	14.5	8.274	7.193	6.028	16.20	7.49	5.495	26.66
QPSK	15.5	8.274	6.974	5.997	14.01	7.13	5.716	19.85
QPSK	16	8.274	8.082	7.458	7.72	7.93	6.185	21.96

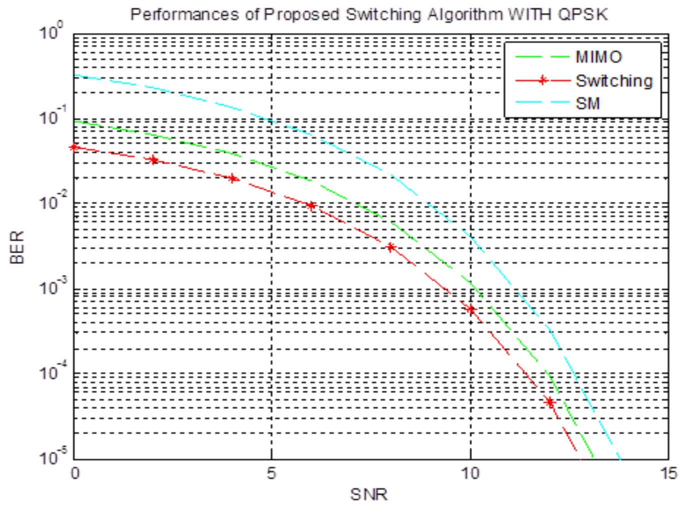

Fig. 5: Performance of BER Vs. SNR for QPSK

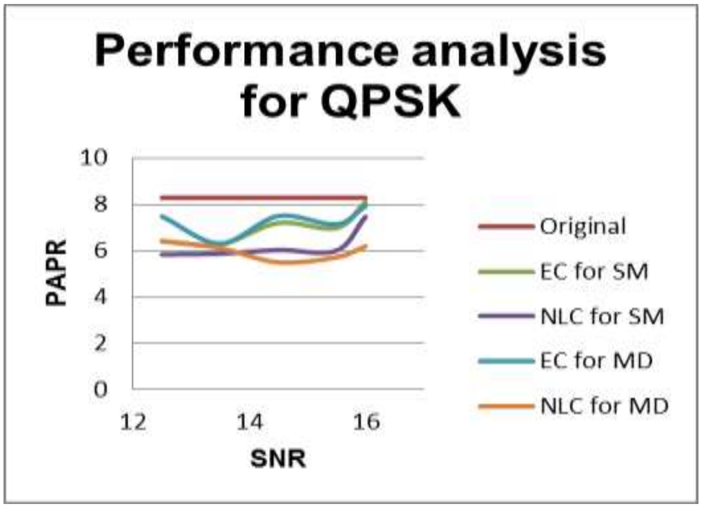

Fig. 6: Performance of PAPR Vs. SNR for QPSK.

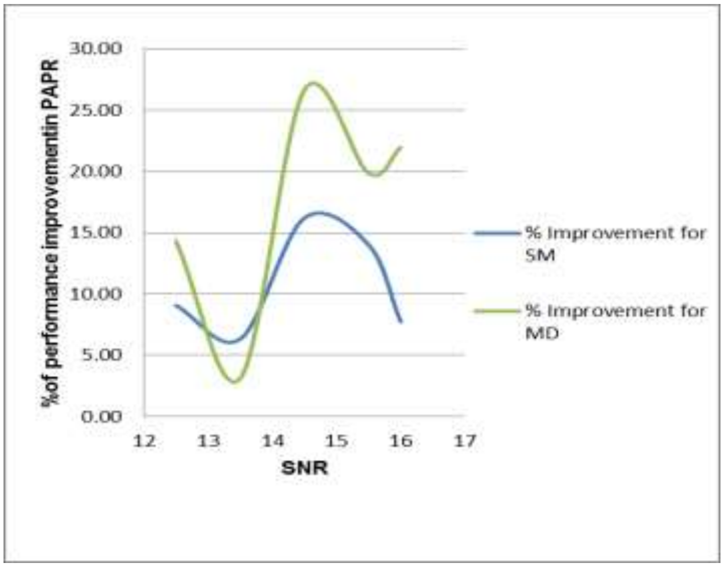

Fig. 7: Percentage of PAPR improvement using NLC for QPSK.

For QPSK modulation technique MD shows better performance than SM. For 16 MHz bandwidth and 14.5 dB SNR the percentage of PAPR improvement for SM is 16.20 % where as for MD it is 26.66 %.

2) For 16 QAM modulation technique

Table - 2
Performance Analysis of 16QAM

Modulation	SNR	SM				MD		
		Original	EC	NLC	% Improvement for SM	EC	NLC	% Improvement for MD
16QAM	18.5	8.274	7.521	5.884	21.77	6.48	6.34	2.19
16QAM	19.5	8.274	6.705	6.197	7.58	7.4	6.109	17.49
16QAM	20.5	8.274	7.388	5.882	20.38	8.13	6.991	13.97
16QAM	21.5	8.274	7.531	6.409	14.90	6.37	6.034	5.30
16QAM	22	8.274	6.261	5.865	6.32	6.31	6.11	3.11

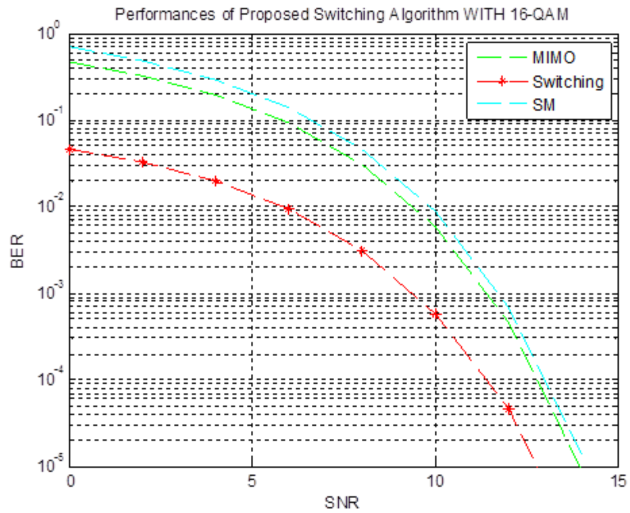

Fig. 8: Performance of BER Vs. SNR for 16-QAM

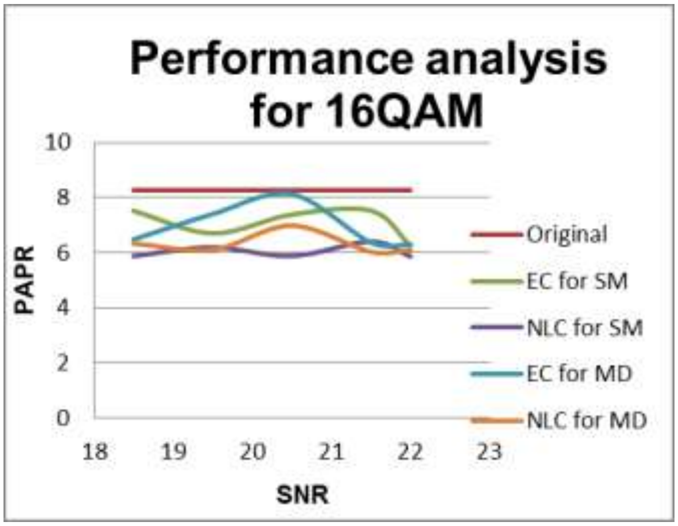

Fig. 9: Performance of PAPR Vs. SNR for 16 QAM.

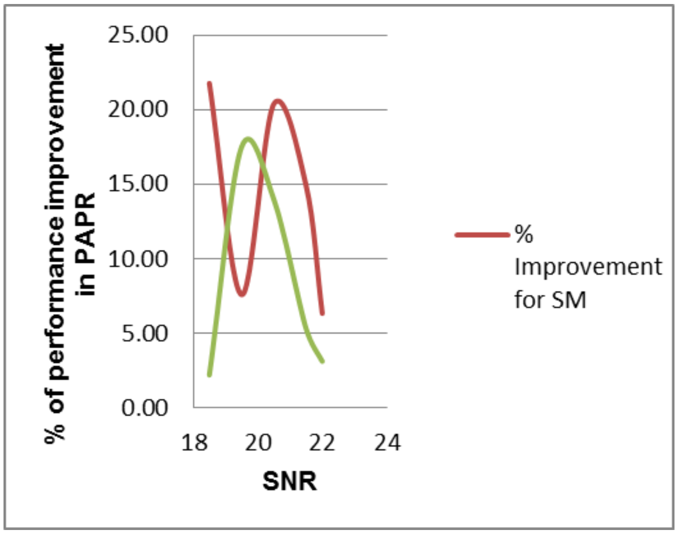

Fig. 10: Percentage of PAPR improvement using NLC for 16 QAM.

For 16 QAM modulation technique SM shows better performance than MD. For 12 MHz bandwidth and 18.5 dB SNR the percentage of PAPR improvement for SM is 21.77 % whereas for MD it is 2.19 %.

3) For 64 QAM modulation technique

Table -3
Performance Analysis of 64QAM

Modulation	SNR	SM				MD		
		Original	EC	NLC	% Improvement for SM	EC	NLC	% Improvement for MD
64QAM	25	8.274	7.01	5.446	22.31	6.22	5.704	8.31
64QAM	25.5	8.274	7.142	5.999	16.00	6.43	5.83	9.30
64QAM	26	8.274	7.242	5.507	23.96	6.91	6.167	10.74
64QAM	26.5	8.274	7.197	6.211	13.70	7.52	6.411	14.72
64QAM	26.5	8.274	7.403	6.153	16.89	7.1	5.622	20.82

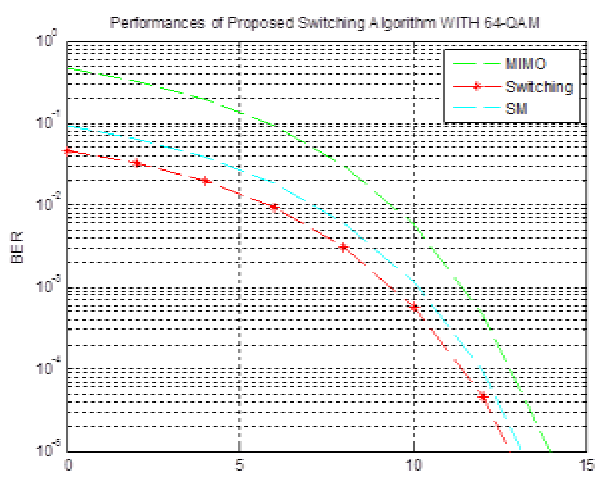

Fig. 11: Performance of BER Vs. SNR for 64-QAM.

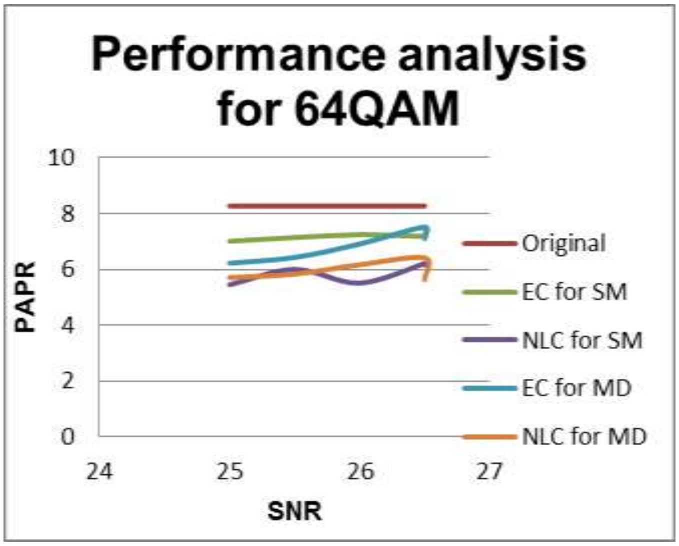

Fig. 12: Performance of PAPR Vs. SNR for 16 QAM

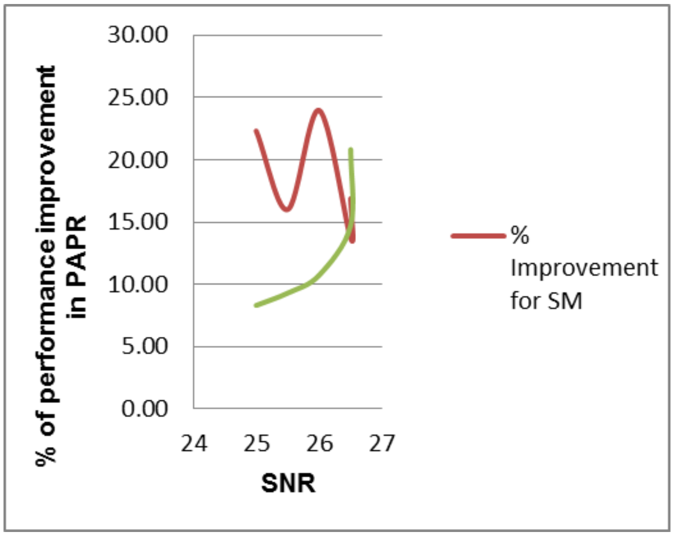

Fig. 13: Percentage of PAPR improvement using NLC for 64 QAM

For 16 QAM modulation technique SM shows better performance than MD. For 16 MHz bandwidth and 26 dB SNR the percentage of PAPR improvement for SM is 23.96 % where as for MD it is 10.74 %.

V. Conclusion

In this paper a novel approach is proposed for development of an OFDM-MIMO reconfigurable architecture based on the Demmel condition number. This algorithm switches between the MIMO diversity and the spatial Multiplexing. This method is basically proposed to improve the performances of BER under the different modulation schemes. In this paper, another research problem is related to PAPR reduction. The practical result shows the proposed new framework with efficient PAPR method gives better performance under different network modulation schemes.

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