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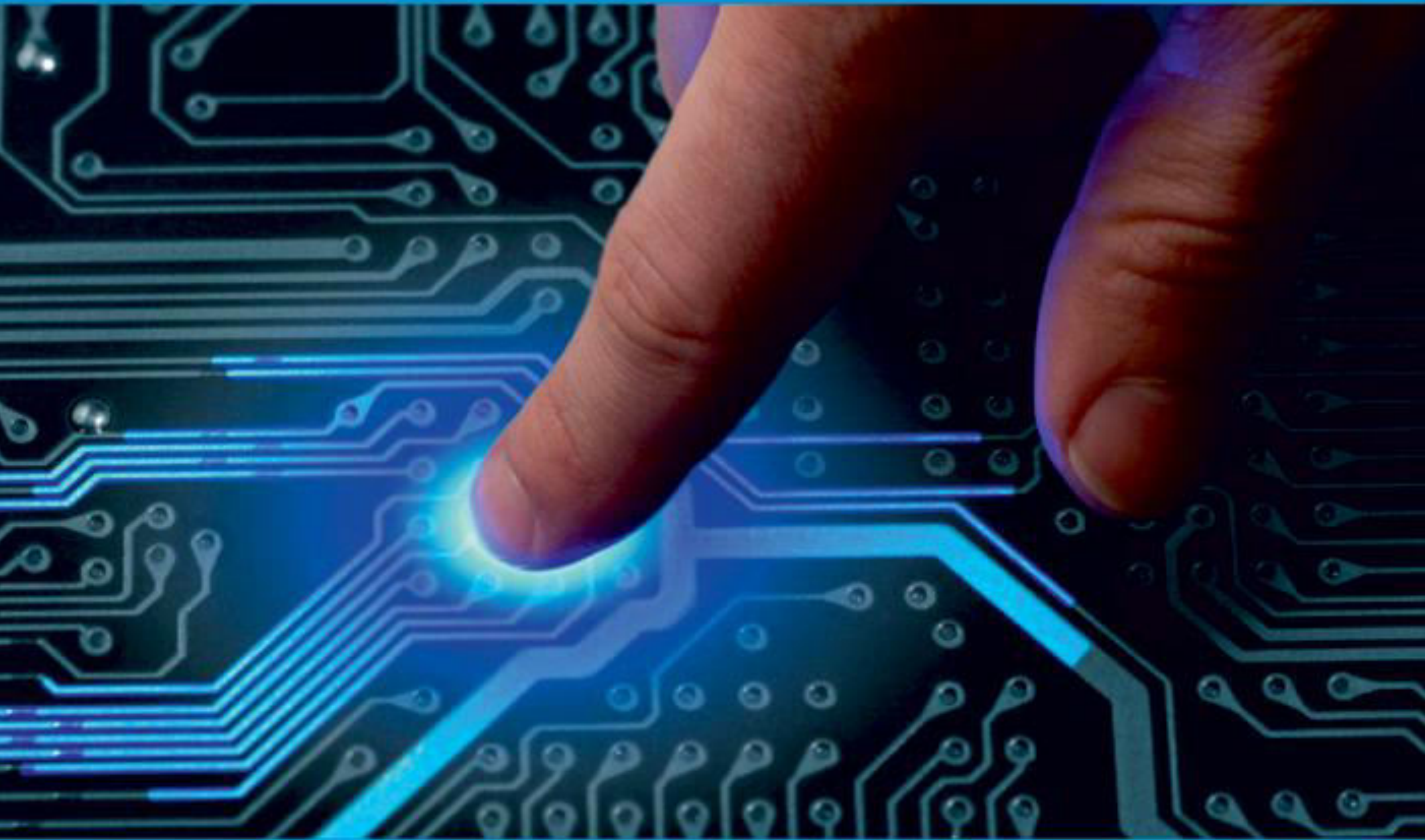

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Selective Mapping Algorithm for Paper Reduction of Space Frequency Coded OFDM Systems

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ABSTRACT: Selected mapping (SLM) is a well-known technique for peak-to-average-power ratio (PAPR) reduction of orthogonal frequency-division multiplexing (OFDM) systems. In this technique, different representation of OFDM symbols are generated by rotation of the original OFDM frame by different phase sequences, and the signal with minimum PAPR is selected and transmitted. To recompense for the effect of the phase rotation at the receiver, it is necessary to transmit the index of the selected phase sequence as side information (SI). In this Project, we have used a simple approach based on Selective Mapping Algorithm to reduce the PAPR of SFBC-OFDM signals. Using simulations, we obtained the values of selective mapping technique to reduce PAPR without degradation in BER. We have presented the PAPR Vs CCDF performance for all the techniques considered. The proposed technique is able to achieve a PAPR of 8.5 dB while BER value at the performance bound at an SNR of 10 dB.

KEYWORDS: Orthogonal frequency-division multiplexing (OFDM), PAPR, SLM, SFBC.

I. INTRODUCTION

The Orthogonal frequency-division multiplexing (OFDM) is a well-known technique for transmission of high rate data over broadband frequency-selective channels [1]. One of the drawbacks of OFDM systems is high peak-to-average-power ratio (PAPR), which leads to the saturation of the high-power amplifier. Thus, a high-dynamic collection amplifier is needed, which increases the cost of the system. OFDM has been designed to improve the capacity of CDMA systems and satisfies the wireless access method for 4G systems Eric Philips. OFDM is believed to perform a better way in the case of frequency selective fading or narrowband interference. OFDM has been employed in various wireless method as like digital audio broadcasting (DAB), digital video broadcasting (DVB-T), the IEEE 802.11a, High Performance LAN type2 (HIPERLAN/2) and Mobile Multimedia Access communication (MMAC) systems and Anibal. OFDM is a Multicarrier Transmission technique which divides the available spectrum into many carriers each one being modulated by a low data rate stream.

The frequency-domain symbols of an OFDM frame is denoted by $\mathbf{X} = [X(0), X(1), \ldots, X(N_c - 1)]^T$, where N_c is the number of subcarriers. It is assumed that $X(k) \in C$, where C is the set of constellation points. The vector $\mathbf{x} = [x(0), x(1), \ldots, x(N - 1)]^T$ contains the time-domain samples of the complex baseband OFDM signal as given by

$$x(n) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N_c-1} X(k) e^{j\frac{2\pi nk}{N}} \quad (1)$$

where $j = \sqrt{-1}$, and N/N_c is the oversampling ratio. It is clear that $\mathbf{x} = \text{IFFT}_N\{\mathbf{X}\}$, where $\text{IFFT}_N\{\}$ is the N-point inverse fast Fourier transform (IFFT) operation. The PAPR of the OFDM frame is defined by

$$\text{PAPR}(\mathbf{x}) = \frac{\max_n \left\{|x(n)|^2\right\}}{E\left\{|x(n)|^2\right\}} \quad (2)$$

In general, the PAPR of OFDM signals $x(t)$ is defined as the ratio period between the maximum instantaneous power and its average power during an OFDM symbol.

$$\text{PAPR} = \frac{\max_{0 \le t \le NT} \left[|x(t)|^2\right]}{1/(NT)\int_0^{NT} |x(t)|^2 \, dt} \quad (3)$$

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Reducing the max $x(t)$ is the principle goal of PAPR reduction techniques. In practice, most systems deal with a discrete-time signal, consequently, we have to sample the continuous-time signal $x(t)$ .The using scheme for PAPR reduction in OFDM transmission using hadamard transform[1].the mathematical expectation. According to (1), the time-domain samples are the sum of Nc independent terms. When Nc is large, based on the innermost limit theorem, the time-domain samples include a Gaussian distribution; thus, they may have large amplitudes [2].
To generate OFDM successfully the relationship between all the carriers must be carefully controlled to maintain the Orthogonality of the carriers.
For this reason generated by firstly choosing the spectrum required based on the input data, and modulation scheme used. Both carriers to be produced are assigned same data to transmit. The required amplitude and point of them are calculated based on the modulation scheme, such as clipping and peak canceling, strictly limit the PAPR of the OFDM signals below a given threshold level. SLM and PTS are examples of the probabilistic scheme because several candidate signals are generated and that which has the minimum PAPR is selected for transmission. Besides the PAPR reduction schemes, the single carrier frequency division multiple access (SC-FDMA) scheme has for alleviating the PAPR problem in uplink transmission [2].

Thus, the computational complexity reduction ratio (CCRR) $$\text{CCRR} = \left(1 - \frac{\text{complexity of new PTS}}{\text{complexity of conventional PTS}}\right) \times 100 \quad (4)$$
The presents a method that combine selective mapping and cyclic coding. A decrease in the PAPR is achieved by adding extra carriers referred to as Peak Reduction Carriers (PRC). The phase of the PRCs was set to 0° or 180° and the carriers were turned on or off. There are consequently 3M combinations used for the PRCs for each information codeword (where M is the number of PRCs) as given in [3].
The SLM for PAPR reduction is a non-distortion technique. In this approach, the transmitter generates a set of sufficiently different candidate data symbols, all representing the same information as the original data symbol. As given in [4], the probability of the peak amplitude of the selected OFDM symbol exceeding the given threshold W can be given as

$$\begin{aligned} F_l^c(W) &= \Pr\left(\min_{1 \le p \le P} l_p > W\right) \\ &= \Pr(l_1 > W)\Pr(l_2 > W)\cdots\Pr(l_P > W) \\ &= \left(1 - F_{l_n}(W)\right)^P \end{aligned} \quad (5)$$

Where p l is the peak amplitude of the p th OFDM symbol and (l) lp F l is the complementary cumulative distribution of p l.

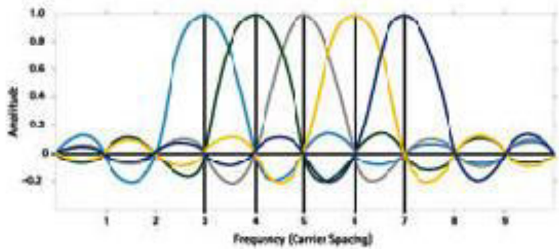

Fig.1 OFDM modulation scheme

The OFDM try to minimize is the interface between channels and it doesn't concern about the quality of each channel which can be overcome using error correction technologies. Figure show what are the major component to implement OFDM such as radio transceivers, FFT processors, system I/O, serial-parallel and parallel-serial converters and OFDM logic. The required spectrum is then converted back to its time domain signal by means of an Inverse Fourier Transform (IFT). In most applications, an Inverse Fast Fourier Transform (IFFT) is used. The IFFT performs the transformation very efficiently and provides a simple way of ensuring the carrier signals produced are orthogonal.
The Fast Fourier Transform (FFT) transforms a cyclic time domain signal into its equivalent frequency spectrum. This is done by finding the equivalent waveform, generated by a sum of orthogonal sinusoidal components. The amplitude and phase of the sinusoidal components represent the frequency spectrum of the time domain signal. The IFFT performs the reverse process, transforming a spectrum (amplitude and phase of each component) into a time domain signal. An IFFT converts a number of complex data points, of length that is a power of 2, into the time domain signal of the same number of points.

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The uses of the bank channel are different connecting US and Europe. US use 30 kHz where as Europe uses 25 kHz band channels of bandwidth. communication of two channels mobile to base (up) and base to mobile (down) uses true full duplex voice communication link for their transmission. To grant the equally way of transmission between base station and mobile station these full duplex channels are separated by 10-20MHz.

II. EXISTING METHOD

2.1 Selected mapping Technique:

Selected mapping (SLM) is a well-known technique for peak-to-average power ratio (PAPR) reduction of orthogonal frequency-division multiplexing (OFDM) systems. In existing system, an SLM technique is introduced for the PAPR reduction of space-frequency-block-coded OFDM systems with Alamouti coding scheme. Among these symbols, the symbol which has the smallest PAPR value is selected and the information of the selected data symbol is transmitted as the side information.

Using several transmitter antennas, one can improve the data rate or bit error rate (BER) of wireless systems. Fig.2 In spatial multiplexing systems, independent symbols are transmitted from several antennas, and this leads to the increase in data rate.

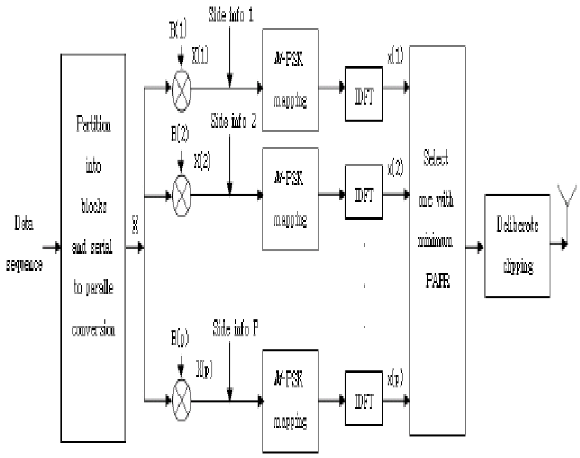

Fig.2 The OFDM system combining clipping and SLM

2.2 Selective Mapping:

The CCDF of the original signal sequences PAPR above threshold PAPR0 is written as $P_r\{PAPR > PAPR_0\}$ Thus for K statistical independent signal waveforms, CCDF can be rewritten as $[P_r\{PAPR > PAPR_0\}]^k$ so that probability of PAPR that exceed the same threshold will drop to small value. The probability of PAPR larger than a threshold z can be written as $P(PAPR< z) = F(z)^N = (1 - \exp(-z))^N$.Assuming that M OFDM symbols carry the same information and that they are statistically independent of each other. In this case, the probability of PAPR greater than z is equals to the product of each independent candidate's probability.

This process can be written a

$$P\{PAPR_{LOW} > Z\} = (P\{PAPR > Z\})^M * ((1 - \exp(-z))^N)^M \quad \text{-- (6)}$$

In selected mapping method, firstly M statistically independent sequences which represent the same information are generated, and next, the resulting M statistically independent data blocks $S_m = [S_{m,0}, S_{m,1}, \dots, S_{m,N-1}]^T, m = 1,2,\dots,M$ are then forwarded into IFFT operation simultaneously. Finally, at the receiving end, OFDM symbols $x_m = [x_1, x_2, \dots, x_N]^T$ in discrete time-domain are acquired, and then the PAPR of these M vectors are calculated separately.

2.3 Combination of Deliberate Clipping and SLM:

The implementation of deliberate clipping is quite simple and effective in PAPR reduction, but larger clipping ratio results in the severe BER performance degradation. On the other hand, the SLM technique does not cause distortion on the error performance if there are no errors in the side information however, in order to obtain effective PAPR reduction ability like clipping method, the system complexity becomes challenging as the number of the candidate symbol sin creases.

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Thus, Fig.3 the use of only deliberate clipping or only SLM technique cannot obtain satisfactory error performance and moderate system complexity simultaneously. However, if these two approaches are combined, the effective PAPR reduction can be achieved with reasonable BER performance and suitable system complexity.

The BER performance for clipped selected OFDM signals can be calculated

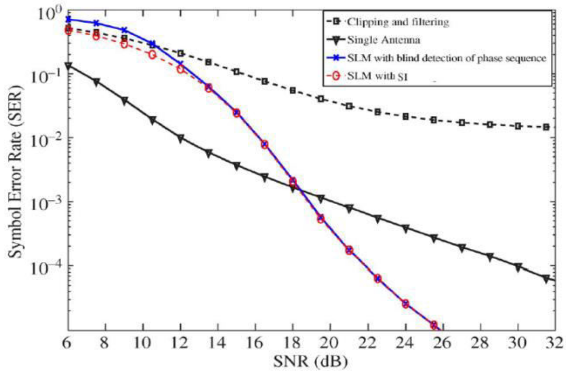

Fig.3 SER performance of the SI -OFDM system with two transmitter antennas and *Nc* = 128 with three different PAPR reduction methods.

III. OUR CONTRIBUTIONS

The simplified method that has been previously proposed for spatially multiplexed OFDM systems is suitable for PAPR reduction of SFBC-OFDM systems. In fact, the simplified SLM does not change the Orthogonality of space frequency codes. In this project, a simple technique for the reduction of high Peak to Average Power Ratio (PAPR) based on Clipping and Differential Scaling in Space Frequency Block Coded Orthogonal Frequency Division Multiplexing (SFBC-OFDM) systems. Additionally, a suboptimum detection method that does not need SI is introduced at the receiver side.

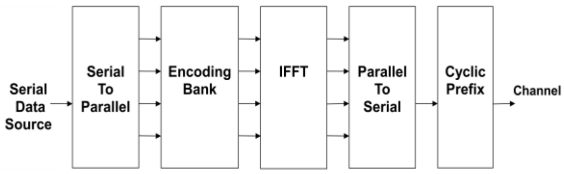

Fig.4 Block diagram of the SFBC-OFDM &SLM

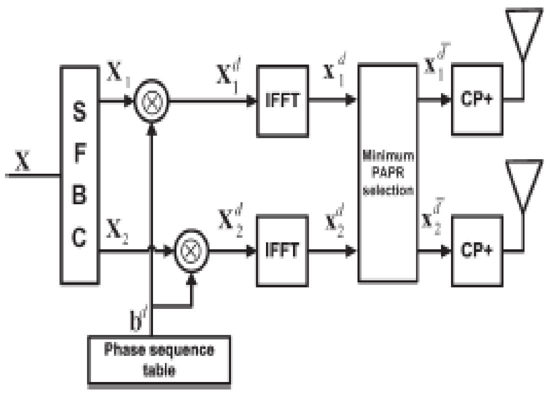

Fig.5 Block diagram of the SFBC-OFDM transmitter with two transmitter antennas and the SLM method for PAPR reduction.

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As shown in Fig. 4&5, the vectors **X**1 and **X**2 are passed through the IFFT operation to yield the time-domain samples $x1(n)$ and $x2(n)$, $0 \leq n \leq N - 1$. It is noteworthy that the Orthogonality of the space frequency matrix **C** in (5) leads to full diversity at the receiver side.

$$\mathbf{CC}^H = \left(|X(2\nu)|^2 + |X(2\nu+1)|^2\right)\mathbf{I}_2 \quad (7)$$

Where **I***n* is the $n \times n$ identity matrix. The PAPR of the *p*th antenna is defined by

$$\text{PAPR}\{\mathbf{x}_p\} = \frac{\max_n \left\{|x_p(n)|^2\right\}}{E\left\{|x_p(n)|^2\right\}}, \qquad p = 1, 2 \quad (8)$$

Where *E{.}* is the mathematical expectation. The overall PAPR of the SFBC-OFDM system is defined by

$$\text{PAPR} = \max_{p \in \{1,2\}} \text{PAPR}\{\mathbf{x}_p\}. \quad (9)$$

They also require excessive amount of IFFT calculations and therefore the complexity associated is very high.

3.1 Selected Mapping For Peak-To-Average Power Ratio Reduction Of Space-Frequency Block Coded Orthogonal Frequency-Division Multiplexing Systems:

The Vectors **X**1 and **X**2 can be multiplied by *D* different phase sequences to yield the minimum PAPR representation, but the SFBC structure must remain constant, so that full diversity can be achieved. Simplified SLM for PAPR reduction of spatial multiplexed OFDM has been proposed. In this scheme, the OFDM frames of the antennas are simultaneously modified with the same single-phase sequence. This leads to reduction in the number of bits that must be transmitted as SI.

In this paper, this approach is used for SFBC-OFDM systems. It is shown that, if this method is used for the SFBC-OFDM system, then the intrinsic redundancy of space frequency coding can be used to detect the index of the phase sequence at the receiver side without SI. Based on these approach D different representations of the signals **x**1 and **x**2 are generated as follows:

$$\mathbf{x}_1^d = \text{IFFT}_N\{\mathbf{X}_1 \otimes \mathbf{b}^d\}$$

$$\mathbf{x}_2^d = \text{IFFT}_N\{\mathbf{X}_2 \otimes \mathbf{b}^d\}, \qquad 0 \leq d \leq D-1 \quad (10)$$

It has been shown that a simple and optimal choice for the phase sequences is a random selection of 0 and π with equal probabilities.

In the method, the complexities of FFT operation, channel estimation, and synchronization do not change, and only the SFBC decoding is done twice: once for the calculation of the $\dot{Z}_+(k)$ and the another for that of $\dot{Z}_-(k)$. To calculate FFT with length *Nc*, 3*Nc* log2(*Nc*) real additions (RAs) and 2*Nc* log2(*Nc*) real multiplications (RMs) .

$$\text{Percentage of additional RAs}(\%) = \frac{\text{SFBC RAs}}{\text{SFBC RAs} + \text{FFT RAs}} = \frac{13}{13 + 3\log_2(N_c)} \times 100\%$$

$$\text{Percentage of additional RMs}(\%) = \frac{\text{SFBC RMs}}{\text{SFBC RMs} + \text{FFT RMs}} = \frac{16}{16 + 2\log_2(N_c)} \times 100\%. \quad (11)$$

The SLM technique can be applied to SFBC-OFDM systems with two transmitter antennas and Almouti coding scheme without changing the Orthogonality of space frequency coding. In this method, the optimum phase sequences applied to the OFDM frames of two antennas such that the SFBC structure remains constant. Then, OFDM symbols and phase sequences are multiplied by using element-by-element production. Then, it is passed through the Inverse Fast Fourier Transform (IFFT). IFFT is used to convert the frequency domain signals into time domain signals.

3.2 Space Frequency Block Coding:

Space-Frequency Block Codes (SFBCs) are the subset of space block codes. When applied in the frequency dimension, Alamouti pre coding involves two frequency components on to two antennas over two different frequencies. This results in Alamouti SFBC. Classically, these two frequencies are chosen to correspond to adjacent subcarriers, the variations of the channel are minimal. Use of space-frequency block coded (SFBC) OFDM signals is advantageous in high-mobility broadband wireless access, where the channel is highly time- as well as frequency-selective because of which the receiver experiences both inter-symbol interference (ISI) as well as inter-carrier interference (ICI).

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3.3 Inverse Fast Fourier Transform

An inverse Fourier transform converts the frequency domain data set into samples of the corresponding time domain representation of this data. Specifically, the IFFT is useful for OFDM because it generates samples of a waveform with orthogonal frequency components. IFFT is the key factor of orthogonal frequency division multiplexing. It is used to convert the frequency domain signals into time domain signals and it is a low cost implementation.IFFT selects the gap of the sub-carriers in a specific way that at the frequency where we calculate the received signal all of the other signals are zero.

IFFT method is employed to transform these signals into the time domain. Every separate samples of the IFFT specifies to a single sub-carrier, before convert them into the time domain. Almost all of these sub-carriers adapted with data.
The external sub-carriers are not adapted with data and have the amplitude value of zero. These zero amplitude sub-carriers work as a frequency guard band before the nyquist frequency and efficiently work as an interpolation of the signal and permits for a practical roll off in the analogue anti-aliasing reconstruction filters.

3.4 Cyclic Prefix:

The cyclic prefix is actually a copy of the last portion of the data symbol appended to the front of the symbol during the guard interval. By adding a cyclic prefix, the channel can be made to behave as if the transmitted waveforms were from time minus infinite, and thus ensure Orthogonality, which essentially prevents one subcarrier from interfering with another (called inter carrier interference or ICI).
This is accomplished because the amount of time dispersion from the channel is smaller than the duration of the cyclic prefix. After discovering the process for OFDM, a cyclic prefix has been proposed for other modulations to improve the robustness to multipath.

IV. SIMULATION RESULTS

The performance of the proposed method has been evaluated for two different OFDM frame lengths *Nc* = 128 and *Nc* = 512. The symbols *X*(*k*) are chosen from the QAM constellations.

4.1 Performance in PAPR Reduction

The performance of the proposed method in PAPR reduction is evaluated by the complementary cumulative density function (CCDF) of the PAPR, which is defined as

$$\mathrm{CCDF}(\mathrm{PAPR}_0) = \Pr\{\mathrm{PAPR} \geq \mathrm{PAPR}_0\} \quad (12)$$

In SFBC-OFDM system, if the amplitude of the signal is larger than the saturation point of power amplifier (PA), the power amplifier forced to work in a nonlinear region so the signal needs to be clipped. In the design of practical SFBC-OFDM systems, PAPR plays an important role because it can be used as criteria to measure the Clipping and Scaling probability. In this chapter, look the performances of conventional PAPR reduction schemes, which were investigated by computer simulations using MATLAB.
Peak-to-average Power Ratio was reduced by using Selective Mapping (SLM) the Fig.5 total no of carriers 128.

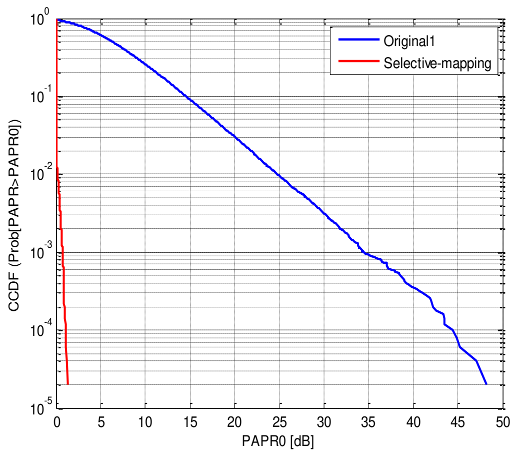

Fig.5 Simulation result of Selective Mapping Nc=128

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Peak-to-average Power Ratio was reduced by using Selective Mapping (SLM) the total no of carriers 256.

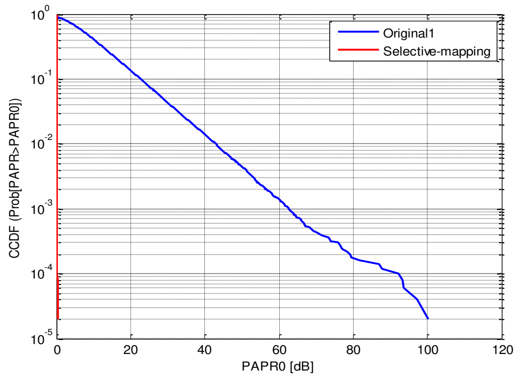

Fig.6 Simulation Result of Selective Mapping NC=256

V. CONCLUSION

The Selected mapping (SLM) is a well-known technique for peak-to-average-power ratio (PAPR) reduction of orthogonal frequency-division multiplexing (OFDM) systems. In this Project, we have used a simple approach based on Selective Mapping Algorithm to reduce the PAPR of SFBC-OFDM signals. Using simulations, we obtained the values of selective mapping technique to reduce PAPR without degradation in BER. We have presented the PAPR Vs CCDF performance for all the techniques considered. The proposed technique is able to achieve a PAPR of 8.5 dB while BER value at the performance bound at an SNR of 10 dB.

FUTURE WORK

In this project, a simple technique for the reduction of high Peak to Average Power Ratio (PAPR), based on Clipping and Differential Scaling, in space frequency block coded Orthogonal Frequency Division Multiplexing (OFDM) systems is proposed. In this technique, the amplitude of complex OFDM signal is clipped and then scaled in such a way so that the PAPR is reduced without causing much degradation in bit error rate (BER). The PAPR of the system is considered using simulations for QSK &PSK constellation using Improve SNR.

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