Image Processing and Joint Reduction of PAPR and BER in OFDM System

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Abstract— **By operating OFDM system in our session we can increase the BER by raising the reliability of system and PAPR by increasing power efficiency .These two models have individually been studied in the session but only few work have studied simultaneously reduction of PAPR and BER. By using random network coding we are going to jointly reduced a trade of PAPR in these system. Different representation input information block are generated to achieve minimum BER in our system by using NC matrices. Simulation results shows that the output we achieved is the same PAPR as conventional selective mapping (C-SLM) and trade off this gain against BER degradation.**

Index Terms— **Multicarrier systems, network coding (NC), Cubic metric (CM), selective mapping (SLM), peak-to-average power ratio (PAPR).**

I. Introduction

In upcoming years a worldwide convergence has occurred for the use of Frequency Division multiplexing technology was technique as an phenomenal technology for high data rates. Particularly, OFDM technology was adopted by various wireless standards like Wi-Max, IEEE 802.11a,LTE,DVB to increase rapidly in future in wireless communication. OFDM is suited for mainly Multi carrier transmission which is particularly having forms like frequency selective channels and high data rates.

Various PAPR reduction techniques were introduced in the literature, which can be partitioned into two main categories: 1)distortion techniques and 2)distortion-less techniques. Examples of distortion techniques are companding [2] and clipping[3]. As SNR is reduced by means of distortion –based PAPR reduction techniques, Some techniques in either transmitter [4] or receiver [5] were studied to minimize the effect of signal distortion. Examples of distortion-less techniques are partial transmit sequence [6],selective coding [7], systematic coding [8].

Further, at the input side cyclic redundancy is introduced which reduce the complexity to only FFT processing and equalization of one top scalar at the output side. These system can also provide redundancy in multipath fading. These method is also going to used for future band application and fourth generation transmission technique. OFDM has recently got rising importance wireless network communication since it provides an efficient means to mitigate the error present in these system. OFDM has best application in field of communication mainly in digital field.

II. Important Concepts

A .PAPR

Let **s = [s1,s2,s3,…,sL]** be a modulated sequence of length L within time interval [0,T], where s_i is symbol from signal constellation, L is number of OFDM data subcarrier and T is the OFDM symbol duration. The complex baseband representation of transmitted signal can thus be formulated as

$$x(t) = \sum_{i=1}^{F} s_i . \exp(j2\pi f_i t), \quad 0 \le t \le T \tag{1}$$

where $j = \sqrt{-1}$. The PAPR of $x(t)$ is defined as

$$PAPR = \frac{\max_{0\le t\le T} |x(t)|^2}{\frac{1}{T}\int_0^T |x(t)|^2 \, dt}. \tag{2}$$

A major drawback of PAPR metric is that it doesn't take secondary peaks of power that directly or indirectly affect the performance of power amplifier due to cubic term in amplifier gain characteristic function [9]

$$x_o(t) = G1 \cdot \left(x_i(t) + G3 \cdot |x_i(t)|^3 \right) \tag{3}$$

Where $x_i(t)$ and $x_o(t)$ are amplifier's input and output voltages, respectively.

B. Symbol-Level Versus Block-Level NC

At the physical layer symbol-level NC is performed over various symbols. The term "symbol" is use to describe the unit of data which is define by modulation scheme in physical layer. e.g. one symbol is of 2 bits for quadrature phase shift keying(QPSK) and 4 bits for 16-quadrature amplitude modulation(16-QAM). Symbol-level NC was performed on modulation symbols in our previous work [1].In such operation, size of number of bit represented by the employed modulation level is same as that of size of NC block. Therefore ,the coding operation is performed by using a finite field with proper dimension related to the employed modulation level.

In this paper instead of using modulation symbol based operation, we are using block level NC operation. This operation can increase flexibility and adaptability of the system. The important advantages of block level NC over symbol level NC are mentioned below :

a) Adaptability: Operating finite field and block size selection can randomly be selected by taking different channel condition into consideration as they do not depend on given modulation scheme.
b) Flexibility: Finite field size and block can flexibly change as block division can be performed by not considering modulation. In symbol level NC , due to varying channel conditions modulation scheme is changed, which then results in performance degradation.

C. C-SLM

SLM can be defined as process of forming various output representing input data sequence to a multicarrier modulator by using specific phase rotation sequences and choosing the proper representation which achieves lowest PAPR for transmission. Let,

$$\Phi^{(m)} = [\phi_1^{(m)}, \ldots, \phi_F^{(m)}], \ 1 \le m \le U,$$

be prefixed sequences of phase. Representation of modulated data sequence $\underline{s}$ can be obtained as follows:

$$s_i^{(m)} = s_i . e^{j\phi_i^{(m)}}. \qquad (6)$$

Where $s_i^{(m)}$ is a phase- rotated of s_i .PAPR can be computed using(2),by applying IFFT to this U version(1).The C-SLM then chooses and transmits the version in that we get minimum PAPR amongst these U PAPRs. Through rapid search of phase factor in a phase sequence minimum PAPR can be found by C-SLM .Due to increasing numbers of sub carriers C-SLM requires high operating complexity, the C-SLM propose in [10] is applied in this paper.

D. CM

To get a proper output as compare to PAPR, 3GPP has been adopted by CM for a power capability of a given power amplifier. The CM of a signal is defined as [11]

$$CM = \frac{RCM - RCM_{\text{ref}}}{K_{\text{CM}}} \qquad (4)$$

Where K_{cm} is an empirical slope factor, RCM is an abbreviation for raw CM, and RCM_{ref} is the raw CM of the wideband CDMA voice reference signal.rcm is defined for r(t) as

$$RCM = 20\log\left(RMS\left(\left(\frac{|x(t)|}{RMS\,(x(t))}\right)^3\right)\right) \qquad (5)$$

Where RMS is root mean square value.RCM can be use as performance matric as RCM_{ref} and K_{CM} are constant values. Both PAPR and CM use as performance matric in this paper.

III. BLOCK PUNCTURING

The block puncturing is an additional step to our proposed technique, which further reduce PAPR or CM by iteratively finding and puncturing blocks. It is equivalent to uploading corresponding tones e.g. if block size is 8 bits, and first block is selected for puncturing in a 16-QAM-64-OFDM system. Here 64 is amount of subcarrier data L, then two tones representing first block are unloaded with the symbols corresponding to this block.

Whereas punctured codes generally use less resources for transmission , the proposed blocks puncturing technique doesn't reduce the resource used for transmission. The block puncturing technique is widely using in channel coding. SLM-DPM generate various turbo coded sequences by exploiting punctured turbo codes.

IV. PROPOSED SCHEME

This section, presents a detailed description of our proposed scheme/technique to jointly reduce PAPR and BLER. The NC-SLM approach (instead of C-SLM) is core of this scheme, which uses different NC matrices to generate different representations of the OFDM symbol. The BLER is reduced with help of coding matrices. For further reduction of PAPR, a step called block puncturing is introduced in this technique.

A. NC-SLM TECHNIQUE

Depending on the coefficient matrix design and coding procedures , the original block vector **u** is passed to U NC units.

The output of these U units is [**y**(1), **y**(2), . . . , **y**(U)], which are different vectors of coded blocks each of size N blocks. Each coded block vector is then mapped into a modulation symbol vector **s**(m) = [$s(m)1$, $s(m)2$, . . . , $s(m)L$], where L is the number of data subcarriers. The length of each symbol $s(m)i$ is $Q = log2(M)$, where M is the employed modulation level. After taking IFFT of these U symbols, only the signal with lowest PAPR is proceeded for transmission or forwarding to the block puncturing step. The U different coding matrices can be preset and pre-stored in both transmitter and receiver.

Generally , at the transmitter side there is no any need to transmit the index of selected coding matrix. Instead, the receiver after fast Fourier transform and symbol de-mapping tries to decode the received signal , using the pre-stored U different matrices. Once the decoding is done the cyclic redundancy checks (CRCs) of the decoded frames are examined, and then selects only the frame which passes CRC check as the correctly received frame.

If no any decoded frame passes the CRC check, then the frame is discarded at the physical layer without delivering it to rest of the upper layers. A similar way is used for HARQ in various air interface standards, including IEEE 802.16. As mobile station requires good power amplifier the PAPR problem is a serious problem in it. Hence, only for the means of the uplink transmission these PAPR reduction techniques are used.

B. NETWORK-CODED BLOCK GENERATION

In this scheme at the physical layer, the transmitter divides the input bit stream into blocks of fixed size. Each of these blocks contains a specific number of physical layer symbols. Let K is the number of blocks that can be transmitted over one OFDM symbol , and ui ($i = 1, 2, . . ., K$) is the i^{th} block in OFDM symbol. Let **u** = [$u1, u2, . . . , uK$] is the vector of original blocks in a single OFDM symbol. Let **A**(m) = [$a(m)ij$] ($i \in \{1, . . . , K\}, j \in \{1, . . . , N\}, m \in \{1, . . . , U\}$) be the coding matrix of the m^{th} unit. The elements of **A**(m) are chosen from a Galois field, whose size is determined by number of bits/ block.

V. FIGURES AND DESCRIPTION

A file was transmitted for many S/N ratios for making the plots of the BER. NOISE_LEVEL variable, is the key factor responsible for changing the SNR. The NOISE_LEVEL variable changes in every transmission. The SNR should be specifically in between the range 0.1 to 10. The transmission for operating above simulation was for 5 carriers i.e.32, 64,

128, 256 and 512 respectively. Each time weed to plot SNR vs BER graph. In this plot we get high echoes initially and then values goes on decreasing .The fig.(a) shows above results of SNR and BER and fig(b) gives relation amongst MULTIPATH and BER.

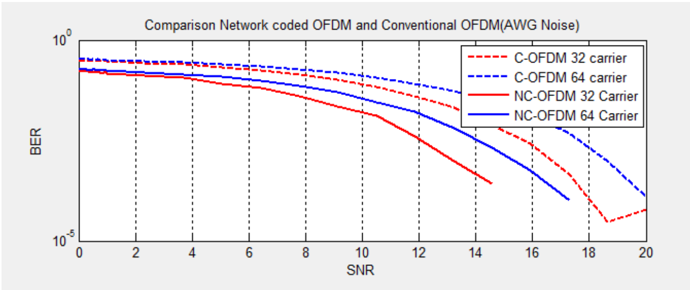

Fig.(a)- SNR vs BER

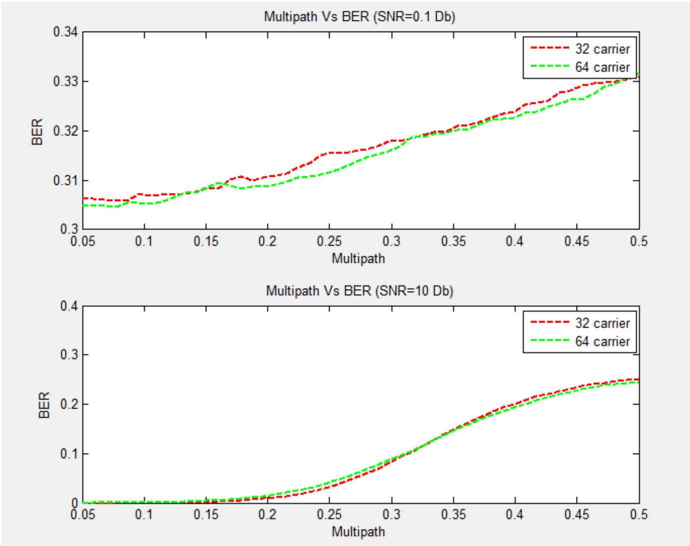

Fig.(b)- MULTIPATH vs BER

VI. ANALYSIS

As we know, OFDM works quite well in AWGN channel and by increasing the power of signal, the picture reception would be more accurate. As far as communication specifically in wireless the main problem regarding transmission of an image is fading which occurs due to Multipath effect. The quality of received image get hampered due to various methods of fading i.e. flat fading and frequency selective fading. Though we get flexible outputs due to the larger size of image Cameraman, there won't be no as such big difference as compare to standard output. Due to OFDM the performance of transmission in fading channel increases. As OFDM technique is the main basis of our simulation, the fading problem is overcome because of the subcarriers. The fig.(c) shows Tx and Rx of an image.

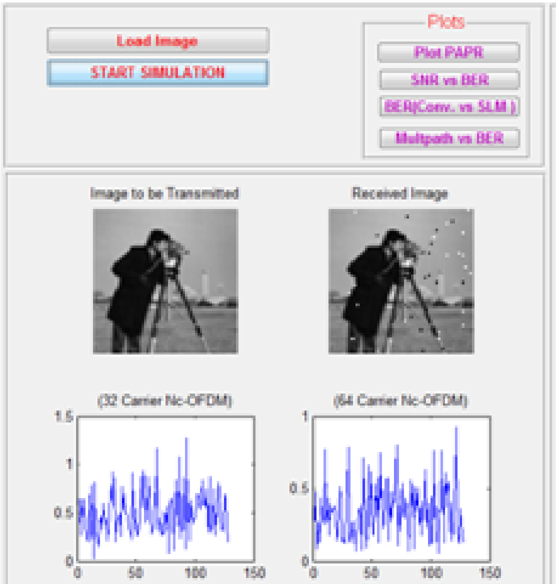

Fig.(c)- Simulation of OFDM system.

CONCLUSION

In now a days demand for high data rate has been rapidly increasing. High complex equalizers are needed at the receiver side for receiving proper transmitted information signal. This errors can be resolved significantly by using multicarrier technique.

The most upcoming technology of this era that is OFDM which we have discussed in our session. Here we take a overview on its concept, its properties in terms of its limitation and its uses in different field. This paper has overviewed the role of OFDM in the wireless communication. By using suitable techniques the limitation of OFDM can be removed.

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Appendixes, if needed, appear before the acknowledgment [1]

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