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Performance Evaluation of Network Coding Selective Mapping Scheme for Reduction of PAPR and BLER in OFDM

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Abstract— Orthogonal Frequency Division Multiplexing (OFDM) is a promising technique to reduce effect of the multipath fading channel for wireless communications. However, in OFDM , the Peak-to-Average Power Ratio (PAPR) is major drawback which gives power inefficiency and nonlinearity of system. Also OFDM have to reduce Block Error Rate (BLER) because of which system becomes unreliable. This paper presents the Network Coded-Selective Mapping (NC-SLM) scheme for joint reduction of PAPR and BLER.

Keywords— OFDM, Peak to Average Power Ratio (PAPR), Block Error Rate (BLER), Network Coding, Selective Mapping.

I. INTRODUCTION

OFDM is a very efficient technique for high-speed data transmission used in mobile communication, Digital Audio Broadcasting (DAB), digital video broadcasting [1], IEEE 802.11 [2], IEEE 802.16 [3], and 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE) [4] standards, wireless asynchronous transfer mode (WATM), Modem/ADSL.OFDM has many advantages such as High spectral efficiency, robustness in frequency selective fading channels, immunity to inter-symbol interference and capability of handling very strong multipath fading. Besides these advantages, however, OFDM is having major drawback of a high Peak-to-Average Power ratio (PAPR).This high PAPR increases complexity as well as affects the efficiency of transmitting amplifier.

Different PAPR reduction techniques can be divided into two main categories: 1) distortion techniques and 2) distortionless techniques. Examples of distortion techniques are clipping [5], peak cancellation and companding [6]. But distortion-based PAPR reduction schemes can lower the signal-to-noise ratio (SNR).Examples of distortionless techniques are selective mapping [8], partial transmit sequence [9], tone injection/ reservation [10], coding technique [7], and active constellation extension [11]. Now a days, selective mapping (SLM) has became more popular, because it provides strong PAPR reduction capabilities, and less complexities in implementation within manageable number of subcarriers [12]–[14].Another important drawback in wireless networks is reduction in transmission error rate to effectively maximize the achievable throughput.

In this paper, we propose a new scheme which combines coding and selective mapping. It is called Network-Coded Selective Mapping (NC-SLM). This method employs NC matrices which achieves the minimum BLER. After selective mapping, the signal with the lowest PAPR is selected. So it is possible to jointly reduce BLER and PAPR.

II. PAPR

The ratio of peak power to average power value is known as Peak to Average Power Ratio. A major disadvantage of the PAPR is that it does not consider the secondary peaks of power that prominently affect the power amplifier performance and increases the complexity [15].

If the complex baseband representation of the transmit signal is represented 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 signal x(t) is defined as,

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

In decibels,

$$PAPR_{db} = 10 \log_{10}(PAPR) \tag{3}$$

Quantitatively, PAPR is usually expressed in terms of Complementary Cumulative Distribution Function

(CCDF) and is mathematically given by,

$$P(PAPR \geq PAPR_0) = 1 - \left(1 - e^{-PAPR_0}\right)^N \quad (4)$$

Where, PAPR0 is the clipping level.

III. PROPOSED SYSTEM

In the proposed system, the data is converted into packets or blocks *K* (segments with crc). These packets are passed through NC encoder. The output of encoder is different vectors of coded blocks, each having size *N* blocks. Each coded block vector is modulated into symbol vector. After IFFT of these symbol streams into transmit signals, the transmitter selects the signal with the lowest PAPR for further transmission. This scheme employs specific NC matrices, instead of phase rotations, to generate various representations of the OFDM symbol.

At the receiver side, the received signal is decoded, after performing fast fourier transform and NC demodulation using prestored NC matrices. After decoding, the cyclic redundancy checks (CRCs) of the decoded frames are performed, and the output frame of CRC check is selected as the correctly received frame.

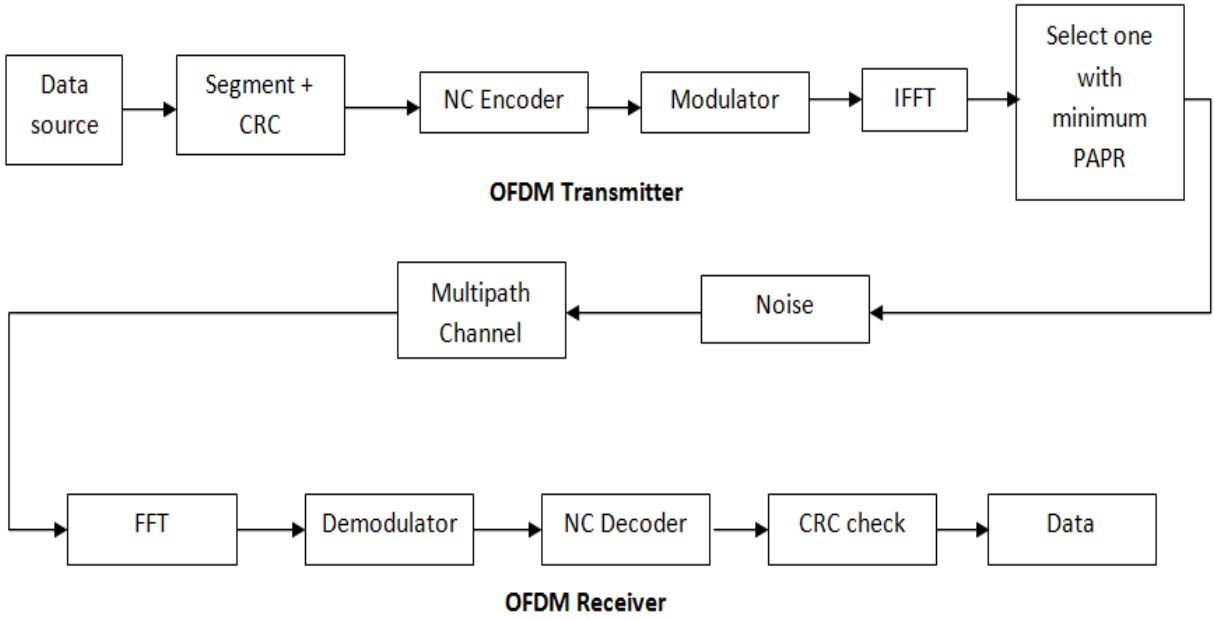

Figure1. Block Diagram of NC-SLM system

IV. SIMULATION RESULTS

In this section we analyze the block coded OFDM system with QAM modulation technique. The NC-SLM and C-SLM are compared to investigate the BLER and PAPR performance. These results are obtained through the simulation using MATLAB.

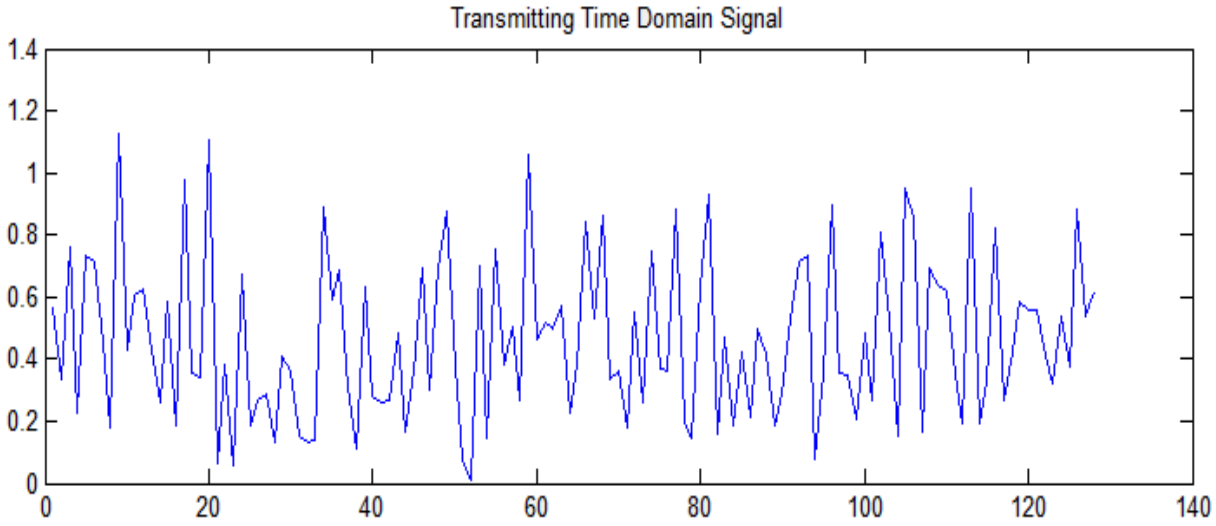

Figure 2. Transmitting time domain signal

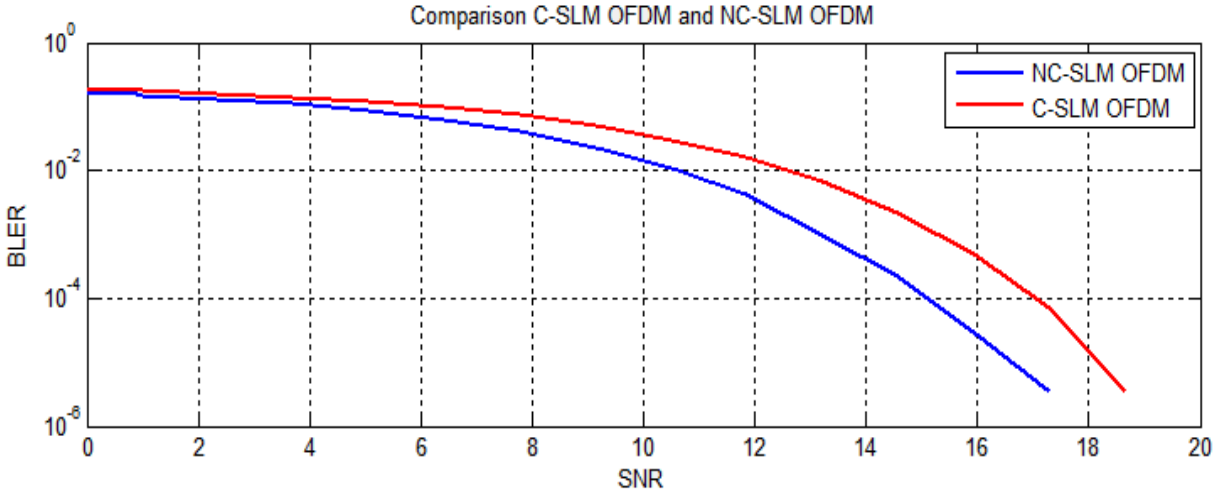

Figure 3. BLER performance of C-SLM and NC-SLM

Fig. 3 shows the BLER performance of C-SLM and NC-SLM under the additive white gaussian noise channel. It is observed that NC-SLM is able to achieve minimum BLER by employing special NC matrices [16].
The complementary cumulative distribution function (CCDF) of the PAPR is a metric used to measure effectiveness of PAPR. It is the probability given by,

$$\text{CCDF}\left(\text{PAPR}\left(x(t)\right)\right) = Pr\left(\text{PAPR}(x(t)) > PAPR_0\right) \tag{5}$$

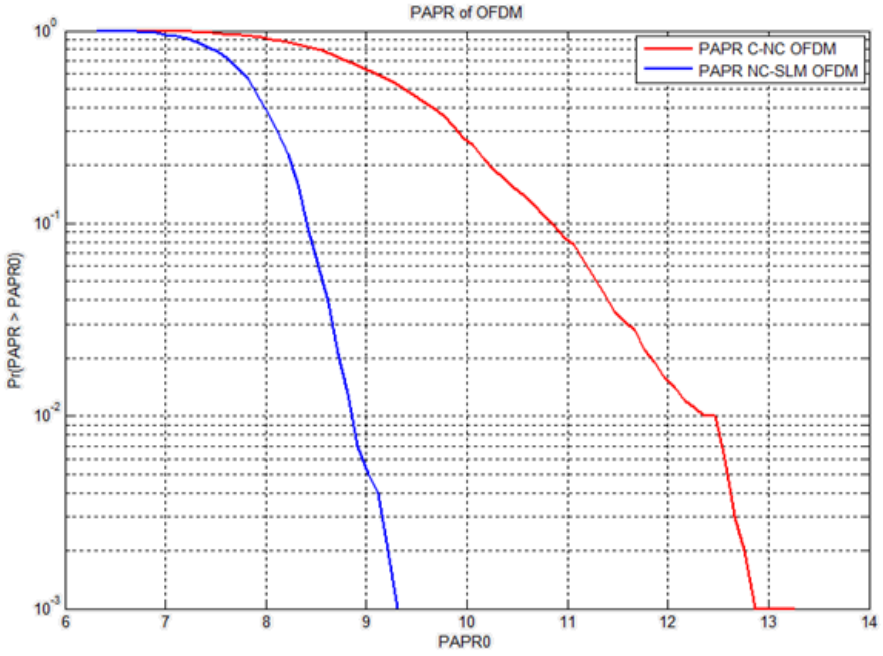

Figure 4. PAPR CCDF performance of C-SLM and NC-SLM schemes

Fig. 4 shows the CCDF performance of the C-SLM and the NC-SLM schemes. In the proposed scheme, data blocks are randomly generated, and after16-QAM symbol mapping and IFFT, the OFDM signal is generated. Here 2000 OFDM signals are simulated, and the CCDF performance of PAPR is observed. The simulation result shows that the proposed NC-SLM scheme reduces PAPR significantly.

V. CONCLUSION

The proposed scheme has used NC coding with selective mapping technique to improve the performance in BLER and PAPR of OFDM system. This proposed system is advantageous to reduce complexity, PAPR and gives better performance of OFDM system. Results of simulation of NC-SLM technique show the PAPR reduction of OFDM system, which further results in high performance of wireless communication. This system provides modern digital signal processing techniques to improve the reliability of the communication links.

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