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Improving of SLM Method with the Simulated Coding

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Abstract: In this paper, we consider a new method for reduction peak to average power ratio (PAPR) of orthogonal frequency division multiplexing (OFDM) signals. We use the SLM method to reduce PAPR and use the coding system for simultaneous improving of error. Finally, we apply the simulation method for generating random matrices in coding system.

Keyword: Turbo coding, IRA coding, PAPR reduction, Simulation.

I. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) can support high data rate and have high reliability. But due to the high peak to average power ratio (PAPR) feature, an OFDM signal may suffer from significant inter-modulation and undesired out-of-band radiation [1-3]. Many people investigated about the reduction of PAPR in the OFDM signals, you can see, [4-8].

This method can be divided into two cases, one using all the sub-carriers and the other using a subset of the sub-carriers called the peak reduction tones (PRT). The PRT, the most widely used is the tone reservation (TR) scheme [9,10]. The TR scheme shows very good PAPR reduction performance. However, it is not easy to find the optimal PRT positions.

In this paper, we proposed a new PAPR reduction technique. This technique is based on the SLM cascade. In the proposed method, for the PAPR reduction, we use coding technique to generate some alternative input sequences.

The paper is organized as follows, we briefly review PAPR of an OFDM signal, and SLM method in section II. In section III, we introduce the coding for changing data in SLM method. We study about improving SLM using coding in different forms in section IV. In section V, the proposed approach for reducing PAPER is explained and discusses the performance of the proposed method with simulation result.

II. CONVENTIONAL SLM SCHEME

In this paper, we want to reduce the maximum value to power average in OFDM system. One of the important methods in reduction parameter PAPR is SLM method. The OFDM signal sequence $a = [a_0, a_1, ..., a_{N-1}]$ using $N = 2^n$ subcarriers can be expressed as

$$a_t = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} A_k e^{j2\pi \frac{k}{N} t}, \qquad 0 \le t < N - 1, \tag{1}$$

where $A = [A_0, A_1, ..., A_{N-1}]$ is an input symbol sequence.

The PAPR of the transmitted OFDM signal can be defined as

$$PAPR(a) = \frac{\max\limits_{0 \le t < N} |a_t|^2}{E[|a|^2]}, \tag{2}$$

where E[·] denotes the expectation operator. To generate U alternative symbol sequences, an input symbol sequence is multiplied by U different phase sequences, each of length N, $P_u = [P_{u,0}, P_{u,1}, ..., P_{u,N-1}]$, $1 \le u \le U$. The first phase sequence P_1 is usually the all-1 sequence. Then, the alternative symbol sequences $A_u = [A_{u,0}, A_{u,1}, ..., A_{u,N-1}]$, $1 \le u \le U$ are generated. After U different alternative symbol sequences are transformed with IFFT, the OFDM signal sequence $a_{\tilde{u}} = IFFT(A_{\tilde{u}})$ with the lowest PAPR is selected for transmission. Modulator OFDM is shown in Figure 1.Here, we use SLM method for reducing PAPR. For the simultaneous improving of error control, we select the random coding, IRA. Since, their generator matrix has less PAPR. In [11], for generating coding with properties of decreasing PAPR, BCH codes is introduced. In [12] is stated a method based on selecting of a pre-code that can be spread every symbol OFDM between all of symbols.

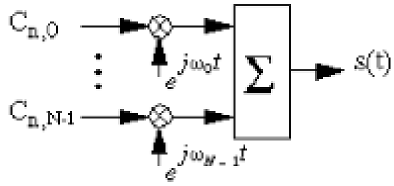

Figure 1: OFDM modulator model

III. USING CODING FOR CHANGING DATA IN SLM METHOD

In fact, IRA codes are subset from irregular codes LDPC and turbo, see Figure 2. A block of data bits $\overline{b} = (b_1,...,b_k)$ by a repetition code with rate k/n. Every b_j repeats r_j times that $(r_1,...,r_k)$ is a string of integer numbers that

$$\sum_{j=1}^{k} r_j = n, \quad 2 \le r_j \le d. \qquad (3)$$

The final block is coded as following form

$$x_{2,j+1} = x_{2,j} + \sum_{i=0}^{i-1} x_{1,aj+i}, \quad j = 0,1,...,m-1,\ x_{2,0} = 0, \qquad (4)$$

Where $\overline{x}_2 = (x_{2,1}, x_{2,2},..., b_{2,m})$ is the collector output block proportional to input x_1 and code with data block $\overline{b}$ is the form of $(\overline{b}, \overline{x}_2)$. The best in show for IRA coding is Tanner graph, you can see [13].

In [14], is used from convolution coding doings on changed data. This coding is obtained a fixed data for other fixed data. In [15] is used a turbo coding for reduction PAPR. This coding due to having interleaving can improve SLM method that this properties has random generator matrix.

Our proper algorithm is shown in Figure 3. The results of system simulation with same coding but in different cases are in figure 4, using Turbo coding.

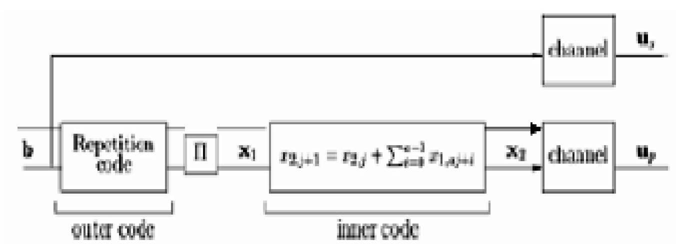

Figure 2: Block diagram of the encoder IRA coding

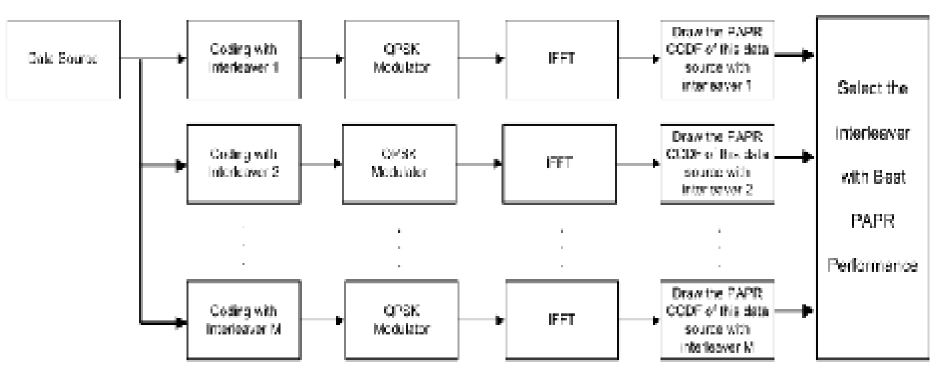

Figure 3: Block of coding effect in different forms in operation of PAPR

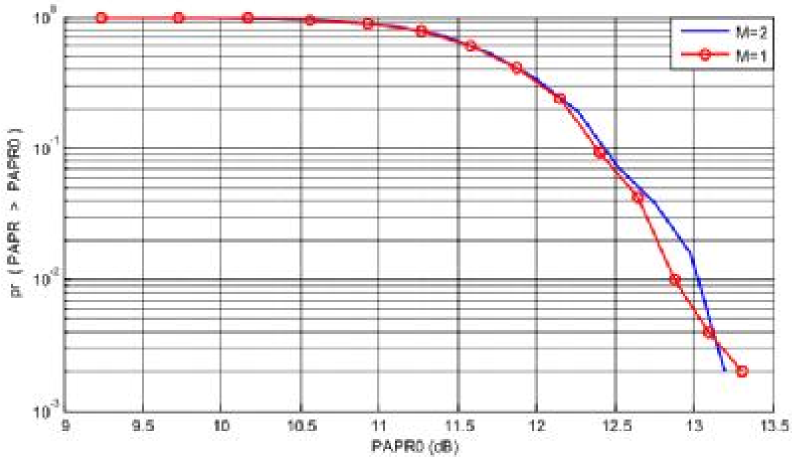

Figure 4: Turbo coding effect with two interleavingin operation of PAPR

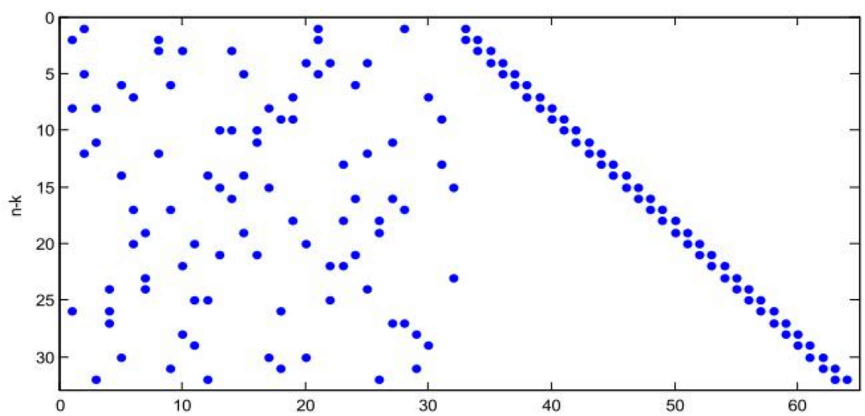

Figure 5: First generated matrix in IRA coding

In Figure 4, it is clear that with fist interleaving, we obtained best results in Turbo coding for PAPR. After selecting interleaving structure, we study this design to consider the system operation. The graph of PAPR with IRA coding by generated matrix is shown in Figure 5 and Figure 6.

It is obvious that if the number of generated matrix in coding IRA be more, we obtain the best selecting. Also, the effects of IRA coding is better than Turbo coding.

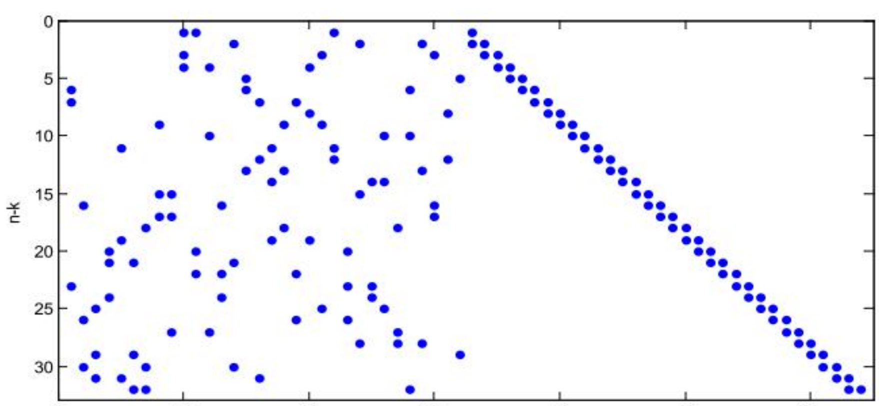

Figure 6: Second generated matrix in IRA coding

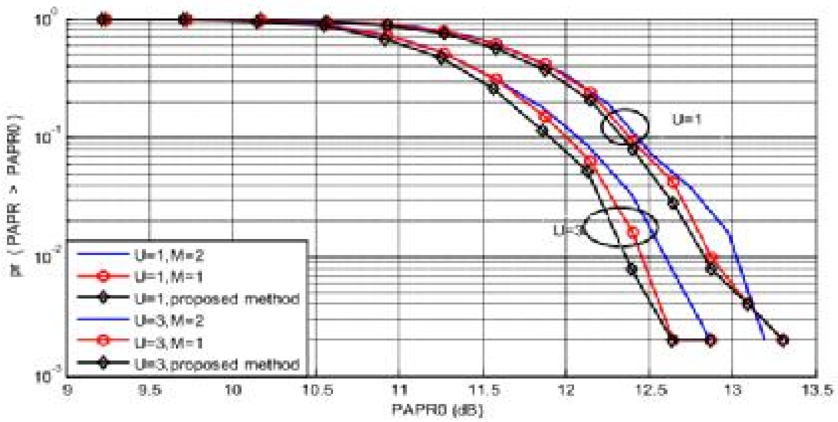

Figure 7: Turbo coding effect with two interleaving in operation of PAPR

IV. IMPROVING SLM USING CODING IN DIFFERENT FORMS

For obtaining the better results, we use M interleaving in Turbo coding or M generated matrix in IRA coding for any data. In this case, every data is coded with M interleaving and then select from M case. This algorithm has more difficulty and should be sent the structure of interleaving with its data. However, we can see in Figure 7 and Figure 8 that this algorithm has considerable improving unto other algorithms.

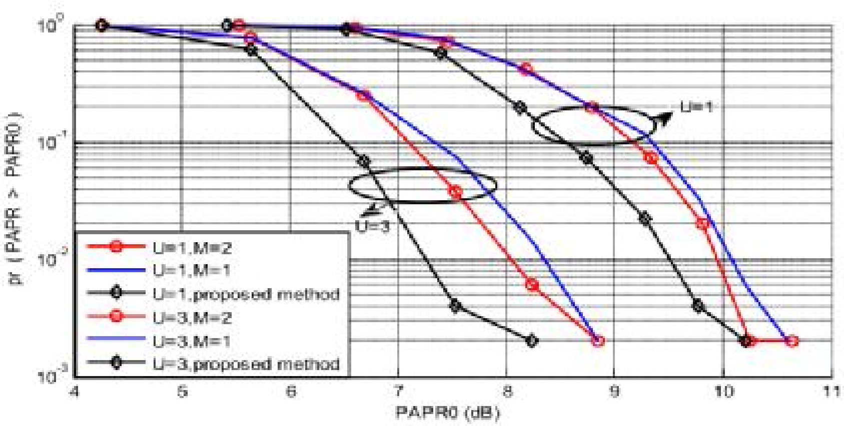

Figure 8: IRA coding effect with two interleavingin operation of PAPR

However, doing coding with different interleaving in turbo coding or different generated matrix in IRA coding is difficult and the time of simulation for sending more data for drawing CDF function is more, but we consider the matrices or interleaving that better. We do not use the large number and change the U for improving the results.

V. THE PROPOSED APPROACH FOR REDUCTION THE COMPLEXITY OF AGO ALGORITHMS

We can improve the complexity of above algorithm in case of special threshold for PAPR is acceptable. In other words, if coded data has less PAPR with first encoder, then we do not use from second encoder, else data is coded with second encoder. Since the second encoder may be does not have desired threshold, we save data with least PAPR after using from any encoder. Also, if previous system cannot obtain the special threshold, then this system cannot.

The simulated result with threshold 13db in turbo coding is in Figure 9. It is clear that this threshold is equal with maximum value of PAPR with first turbo encoder. For comparing, the figure of IRA coding with threshold 9db is shown in Figure 10. It is obvious that the lower threshold is much higher than the PAPR has more reduction.

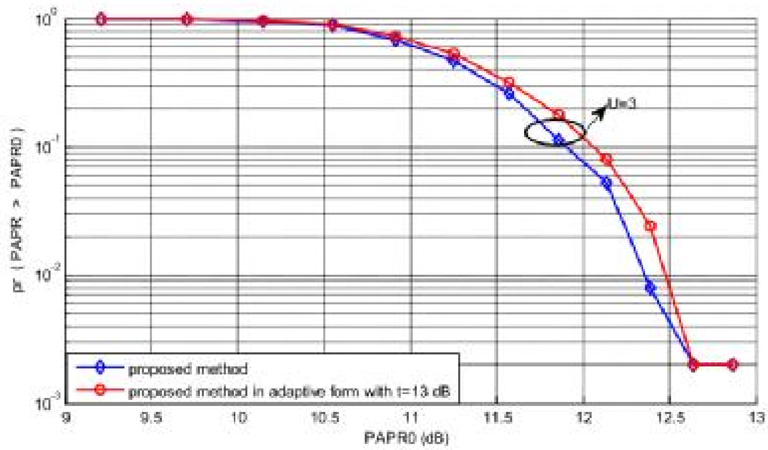

Figure 9: The effect of turbo coding

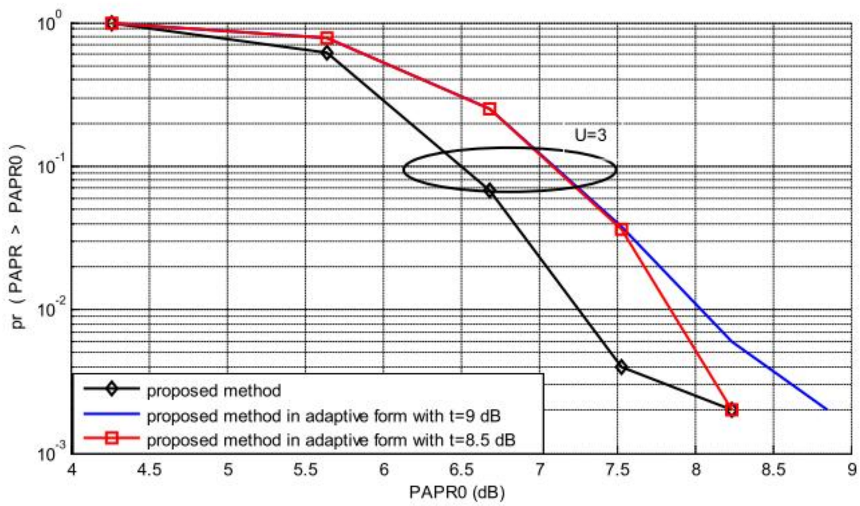

Figure 10: The effect of IRA coding

VI. CONCLUSION

This paper has proposed a new PAPR reduction technique by the SLM cascade with the coding methods. We improved the complexity of above algorithm in case of special threshold for PAPR is acceptable. We compare IRA coding with Turbo coding in generating matrices. We saw that IRA coding generator matrix has less PAPR.

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