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A Low Complexity Architecture for Papr Using Hadamard SLM in SFBC OFDM System

Bharathi. P[1], Prasad. V[2]
[1]Student, Department of ECE, Shree Institute of Technical Education, Tirupathi, India
[2]Associate Professor, Department of ECE, Shree Institute of Technical Education, Tirupathi, India

Abstract: In this paper, we propose a hadamard SLM for the reduction of high peak to average power ration (PAPR) in OFDM systems. In this technique, follows two staps, firstly,The input information is multiplied by a set of phase rotation vectors respectively. Secondly, apply the hadamard transform of each resulting sequence based on SFBC. After to compute the inverse fast fourier transform to get the time domain signal. The proposed method has less computation complexity and better PAPR performance. The experimental results shows that the PAPR reduction performance of hadamard SLMtransform technique and compare to SLM and SLM-2 techniques.
Keywords: mutiple-input mutiple output (MIMO); orthogonal fequency division mutiplexing (OFDM); peak-to-average power ratio (P APR) reduction; space fequency block coding (SFBC); selected mapping (SLM) and hadamard transform.

I. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) has been recently seen rising popularity in wireless applications. For wireless communications, an OFDM-based system can provide greater immunity to multi-path fading and reduce the complexity of equalizers [1]. Now OFDM have been included in digital audio/video broadcasting (DAB/DVB) standard in Europe, and IEEE 802.11, IEEE 802.16 wireless broadband access systems, etc. On the other hand, the major drawback of OFDM signal is its large peak-to-average power ratio (PAPR), which causes poor power efficiency or serious performance degradation to transmit power amplifier [2]. To reduce the PAPR, many techniques have been proposed. Such as clipping, coding, partial transmit sequence (PTS), selected mapping (SLM), interleaving [3][4], nonlinear companding transforms[5] [6], hadamard transforms[7] and other techniques etc. these schemes can mainly be categorized into signal scrambling techniques, such as PTS, and signal distortion techniques such as clipping, companding techniques. Among those PAPR reduction methods, the simplest scheme is to use the clipping process. However, using clipping processing causes both in-band distortion and out-of-band distortion and further causes an increasing of error bit rate of system. As an alternative approach, a companding shows better performance than clipping technique because the inverse companding transform (expanding) is applied in receiver end to reduce the distortion of signal. Hadamard transform may reduce PAPR of OFDM signal while the error probability of system is not increased [8]. In this paper, an efficient reducing PAPR technique based on joint companding and hadamard transform method is proposed. This scheme will be compared with the original system with companding technique for reduction PAPR.

The organization of this paper is as follow. Section II presents the simplified SLM. hadamard SLM is introduced in section III. In section IV, CCDF and PAPR calculations. Simulation results are reported in section V and conclusions are presented in VI.

II. SIMPLIFIED SLM

In the past time spatial SLM method contain K transmit radio wires. In this system perform NK IFFT operations. Thus, calculation unpredictability is high. To reduce the computation complexity using simplified SLM-2 is used. This system produce countless flag sets in the time space without playing out an additional IFFT calculation. Rather than utilizing NT N point IFFTs in traditional SFBC MIMO-OFDM frameworks, our technique requires NT NIK-point IFFTs, which considerably diminishes the framework multifaceted nature.

In this strategy, the input sequence arrangement is multiplied by the phase rotation vector Pv . At that point, we disintegrate the subsequent arrangement into K sub-arrangements. Performing N/K-point IFFT on k-sub-sequent can generate large number of candidate signal sets.. in conclusion In conclusion, the signal set with the lowest P APR is chosen for transmission using PAPR(X)=argmax(PAPR(Xk))

III. HADAMARD SLM TECHNIQUE

In this technique to remove the occurrence of the max peaks comparing the original OFDM system. The idea to use the hadamard

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transform is to remove the autocorrelation of the input data to minimize the peak to average power problem and it requires no side information to be transmitted to the receiver. In the section, we briefly review hadamard transform. We assume H is the hadamard transform matrix of N orders, and hadamard matrix is standard orthogonal matrix. Every element of hadamard matrix only is 1 or The hadamard matrix of 2 orders is stated by

$$H2 = \frac{1}{\sqrt{2}}\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$$

Hadmard matrix of N 2 order may be constructed by

$$H2N = \frac{1}{\sqrt{2N}}\begin{pmatrix} Hn & Hn \\ Hn & -Hn \end{pmatrix}$$

After the sequence X=[X1,X2,…..Xn] is transformed by hadamard matrix of N order, the new sequence is

Y=HX

For to minimize the PAPR of OFDM signal, in this paper we proposed a minimize PAPR scheme that companding transform and hadamard transform are combined to adopt. The coming input data stream is firstly transform by hadamard transform then the transformed data stream is as input to IFFT signal processing unit.

The block diagram of hadamard SLM is shown below

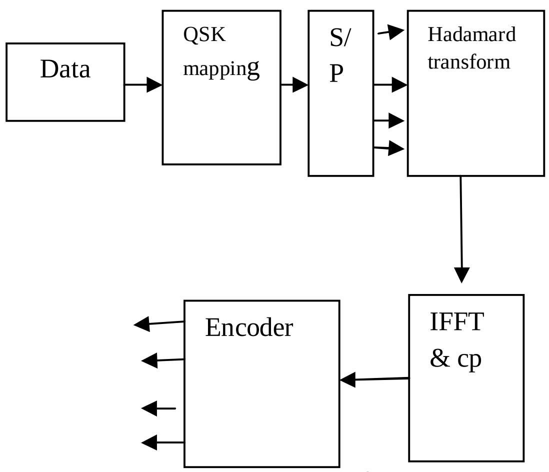

Fig.1. block diagram of HADAMARD SLM

The system block is show at Figure. 1. The signal processing step is below:
The sequence data X is transformed by hadamard matrix, i.e. = YHX
Apply inverse IFFT i.e y=IFFT (Y),
Apply hadamard transform to y
do inverse hadamard transform to get the received signal r(n)
apply FFT transform to the signa y(n)
apply inverse hadamard transform to the signal Y

$X=H^{T}Y,$

Then the signal X is demaped to bit stream.

IV. CCDF AND PAPR CALCULATION

In the case of two transmit antennas wire, the each of *N*-dimensional OFDM symbol is transmitted from transmitter and receiver respectively. Generally, the formula for PAPR of the transmitted OFDM signal is defined as

$$PAPR^{l} = \frac{\max_{0\le t\le T}\left|S^{l}(t)\right|^{2}}{E\left[\left|S^{l}(t)\right|^{2}\right]}$$

where l means the transmit antenna number and $E[\bullet]$ means the expectation operation.

When measurement the PAPR using discrete time sampled signals, we cannot find the exactly PAPR because the true peak of continuous time OFDM signal may be missed in the Nyquist sampling. So, we use multiple times over-sampling to improve accuracy of discrete PAPR. Besides, to show statistical characteristics of PAPR, we use CCDF (Complementary Cumulative Distribution Function) formula , which is the probability that PAPR of OFDM/CIOFDM signal exceeds a certain threshold $PAPR_0$

The CCDF is defined as

$$\begin{aligned} CCDF^l &= \Pr\left(PAPR^l > PAPR_0\right) \\ &= 1-\Pr\left(PAPR^l \le PAPR_0\right) \\ &= 1-\prod_{n=1}^{N}\left[1-\exp\left(-PAPR_0 \times \frac{P_{avg}^l}{P_n^l}\right)\right] \end{aligned}$$

Where P_n^l is the average sample power of l^{th} transmit antenna signal,

$$= 1-\left(1-\exp\left(-PAPR_0\right)\right)^{\alpha N}$$

$$P_{avg}^l = (1/T)\int_0^T \left|S^l(t)\right|^2 dt$$

is the average power of l^{th} transmit antenna signal, here, when oversampling is done, $P_n^l = P_{avg}^l$ is nearly satisfied. Commonly, α is 2.8 in most cases.We define the observed CCDF of MIMO transmitter is

$$CCDF = \max_{0<l\le L}\left(CCDF^l\right)$$

V. EXPERIMENTAL RESULTS

The PAPR reduction performance of the proposed scheme was evaluated by means of numerical simulations. The results shows the PAPR reduction performance of the proposed scheme for an OFDM system with 256 sub-carriers and the 16-quadrature amplitude modulation (16-QAM) scheme.

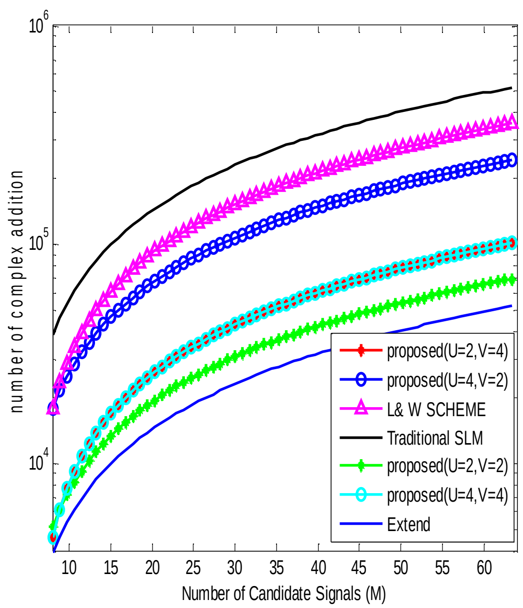

Fig. 5.1. Number of complex additions as function of number of candidate signals M (N = 256).

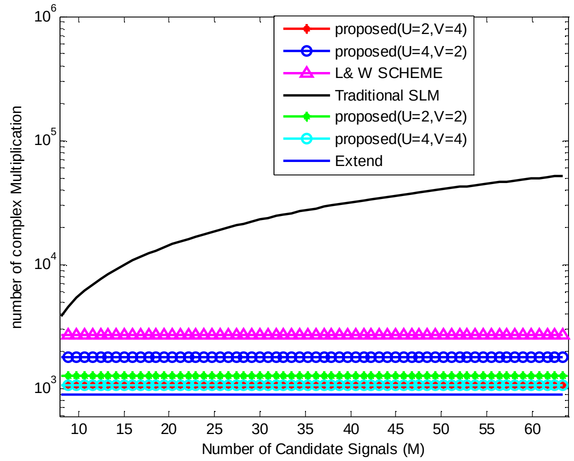

Fig. 5.2. Number of complex multiplications as function of number of candidate signals M (N = 256).

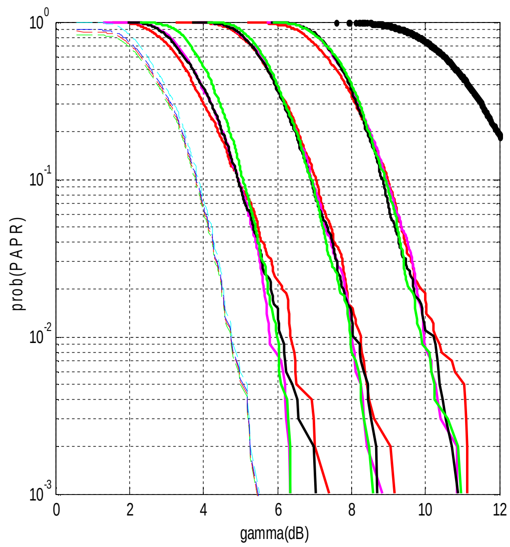

Fig.5.3. PAPR reduction performance of various schemes (16-QAM, N =256).

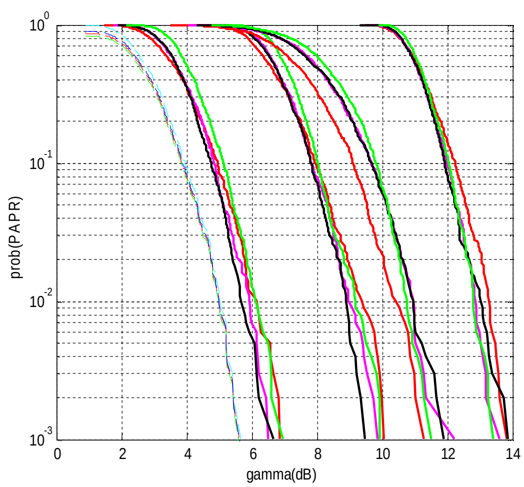

Fig. 5.4. PAPR reduction performance of various schemes (16-QAM, N =512,

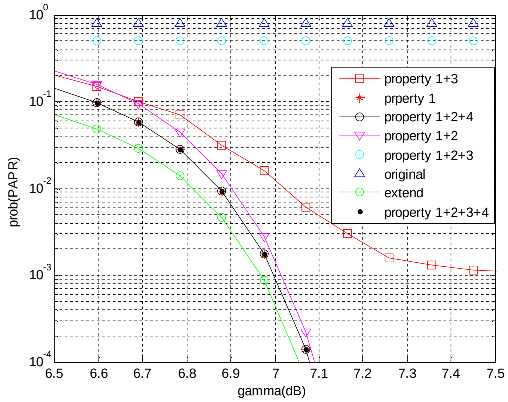

Fig. 5.5. PAPR reduction performance of various combinations of frequencydomain operations (16-QAM, M = 32, N = 256, U = 4, V = 4).

VI. CONCLUSION

This paper has presented new low-complexity architecture for PAPR reduction using hadamard transform in OFDM systems. Compared to the SLM scheme, in which the input sequence signals are generated using frequency-domain phase rotation only, the architecture proposed in this study additionally uses frequency domain signal cyclic shifting, complex conjugate and sub-carrier reversal operations to peak PAPR diversity of the candidate signals. In order to avoid the multiple-IFFT problem inherent in the traditional SLM method, the proposed scheme converts all frequency-domain operations into time-domain equivalent operations. The results state that the PAPR reduction performance is better improved compared with PII and SLM. The hadamard SLM has lower computational complexity, the proposed scheme achieves comparable PAPR reduction performance to the simplifed SLM-2 and PII scheme.

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