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Selective Mapping Single Carrier Communication using Zero Padded Technique

N. Rajkumar[1]
M.E., Communication System
Francis Xavier Engineering College
Tirunelveli – India

W. Stalin Jacob[2]
Assistant Professor, ECE
Francis Xavier Engineering College
Tirunelveli – India

G.Sujeetha[3]
M.E., Communication System
Infant Jesus College of Engineering and Technology
Thoothukudi – India

Abstract: Zero padded single carrier spatial modulation system is an effective method of data transmission. This system achieves full multipath diversity and imposes a relatively low maximum likelihood detection complexity. However the main drawback of this system is that it suffers from high Peak-to-Average problem. In this paper, we propose an effective reduction scheme that combines Discrete Cosine transform and Selective mapping technique along with zero padding. The scheme is composed of the Discrete Cosine transform followed by the Selective mapping using the Riemann matrix to obtain phase sequences for the Selective mapping technique. The simulation results shows that the PAPR can be greatly reduced by applying the proposed system with low complexities computation and the bit error rate performance is significantly better than the zero padded spatial modulation technique. This approach also avoids randomness in phase sequence selection to provide easier decoding at the receiver. Also the matrices can be generated at the receiver end to obtain the data signal and hence it is not required to transmit side information.

Keywords: Selective Mapping (SLM), Zero Padding, Discrete Cosine transform (DCT), Riemann Sequence, Peak to average power ratio (PAPR).

I. INTRODUCTION

The benefits of multi-antenna aided transmission techniques are generally achieved at the cost of a substantial decoding complexity imposed at the receiver. The high decoding complexity at the receiver is due to the inter antenna interference that arises due to the activation of all the antennas at the transmitter. Spatial modulation is a recently developed low-complexity multiple-input multiple-output communication scheme which relies on a single radio frequency chain at the transmitter. In spatial modulation technique the information bit stream is divided into blocks of $\log_2(NtM)$ bits and in each block, $\log_2(M)$ bits select a symbol s from the signal set and $\log_2(Nt)$ bits select an antenna out of Nt transmit antennas for the transmission of the symbol s. Since only one transmit antenna is activated in any symbol duration the inter antenna interference is completely eliminated at the receiver resulting in a low complexity single stream detection at the receiver. The zero padded single carrier spatial modulation technique achieves full multipath diversity under appropriate detection scheme and imposes a relatively low detection complexity. However, the main drawback of this system is that, it suffers from the problem of high Peak-to-Average Power Ratio which could limit transmission efficiency. Due to the increase in Peak-to-Average Power Ratio the number of subcarrier also increases. Hence the power efficiency will be reduced. In some instance serious performance degradation also occurs. Although many peak to average power reduction techniques have been proposed, it should be noted that most of the methods are based on the idea of appropriately selecting the time domain signal to be transmit from a set of different signals in order to minimize the rise in the range of the peak to average power ratio. The techniques are mainly classified as signal scrambling and signal distortion techniques. Signal scrambling techniques are the factor of scrambling the codes to decrease the

PAPR. Generally coding techniques can be used for signal scrambling concept. Complementary sequences based on Golay, M-sequences, Barker codes are some of the coding sequences that can be used to efficiently reduce the PAPR. However with the increase in the number of carriers the search for the efficient best code would increase exponentially. One of the best solutions of the signal scrambling technique is the selective mapping technique.

II. ZP-SC SLM SYSTEM

Consider an efficient reduction of PAPR technique based on zero padded joint SLM using Riemann sequence and Discrete Cosine Transform. So far as we know the closest work to our concept is where zero padding is not used along with SLM model based on Riemann sequence. In this work, the data stream is divided into blocks. The blocks are then zero padded to increase the efficiency .The zero padded data stream is then transformed by discrete cosine transform matrix. The transformed data is processed by the SLM unit where each of the data block is multiplied by different number of phase sequence vectors and each row of a Riemann matrix is taken as the phase sequence for multiplication. Now the data is passed by DCT matrix before IFFT, the autocorrelation coefficient of IFFT input sequence is reduced, then the PAPR could be reduced with low complexity and no side information is required. This is because the matrices can be generated at the receiver to recover the original data with lowest PAPR that is transmitted. However, compared with other SLM techniques, an extra scaling of 1/M (M is the size of the Riemann matrix) for the whole matrix is required for getting the normalized matrix. Simulation results are presented which demonstrate that our proposed scheme achieves significantly better PAPR reduction. Also the bit error performance of the proposed system is significantly better than the zero padded spatial modulation system.

III. PAPR ANALYSIS

In general, the PAPR of a signal is defined as the ratio period between the maximum instantaneous power and its average power.

PAPR is defined as:

$$\mathrm{PAPR} = 10\log_2\left(\frac{\mathrm{P_{peak}}}{\mathrm{P_{AV}}}\right)$$

High Peak-to-Average Power Ratio has been recognized as one of the major practical problem .High peak to average power ratio results from the nature of the modulation itself where multiple subcarriers or sinusoids are added together to form the signal to be transmitted. High peak to average power ratio signals are usually undesirable for it usually strains the analog circuitry. High peak to average power ratio could cause problems when the signal is applied to a transmitter which contains non-linear components such as high power amplifier in the transmitter chain. Peak to average power ratio increases with the increase of the number of subcarrier, which causes poor power efficiency or serious power degradation. The peak to average power ratio has the worst case value peak to average power WC which depends on the number of subscribers N. The idea to use the discrete cosine transform is to reduce the autocorrelation of the input sequence to reduce the peak to average power problem and it requires no side information to be transmitted to the receiver.

IV. PROPOSED PAPR REDUCTION METHOD

A. Riemann Sequence Approach

In the proposed method, rows of normalized Riemann matrix are used as the phase rotation vectors. Riemann sequence rearranges the infinite series which is conditionally convergent and can be arranged in a permutation which paves way for series convergence to any given value.

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B. Selective Mapping (SLM)

In Selective Mapping technique, the input data in sequences are multiplied with each of the phase sequences. It generates different input symbol sequences. Each of these sequences is transformed by Inverse fast fourier transform operation. Then the data sequence with the lower value of PAPR is selected for transmission

C. DCT Transform

DCT transform is used to reduce the autocorrelation of the input sequence which reduces the peak to average power problem. Also it requires no side information to be transmitted to the receiver.

V. PROPOSED SCHEME

In the proposed method, the input bits are divided into block of data. These blocks are then zero padded to increase the spectral efficiency. Zero padding also meets the requirements of the length of the data to be needed for transmission. It is followed by the combination of two appropriate methods. The first one is the Discrete Cosine Transform matrix technique and the other method is the Selected Mapping technique. The transmitter block is shown in Fig.1.While transmitting, the data bits are first transformed by DCT matrix .It is then followed by the Selective Mapping unit. If data block is passed through DCT before IFFT, the autocorrelation coefficients of IFFT input is reduced; hence the PAPR can also be reduced. Now the selective mapping selects the antenna with lowest PAPR for transmitting the bit streams. These bit streams are passed through appropriate channel and maximum likelihood detection is used for receiving the bit streams.

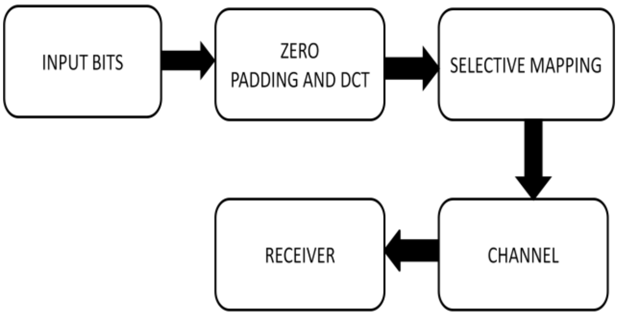

Fig. 1. Block diagram of proposed scheme

VI. RESULT ANALYSIS

In this section the performance of the proposed method is evaluated. Selective mapping technique is used in single carrier communication scenario and the performance output results are displayed with varying number of subcarriers used. The results show that the performance of the proposed method converges faster than the zero padded technique. Also the peak to average power ratio can be reduced and the output is gained efficiently. Following figures displays the various result analysis of the proposed selective mapping technique compared with various parameters.

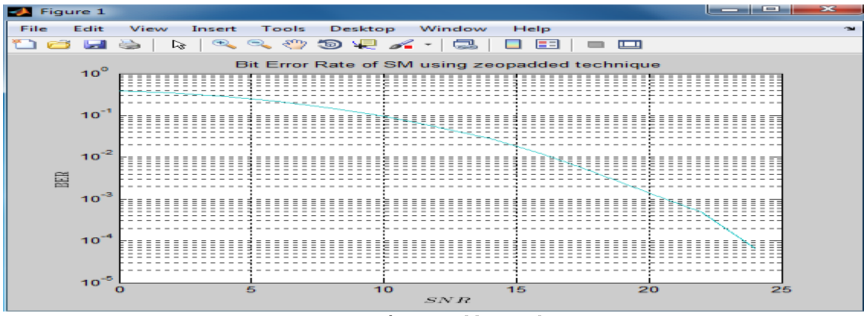

Fig 1: BER of zero padding technique

The figure 1 shows the bit error rate performance of the spatially modulated zero padded technique. The signal to noise ratio of the spatially modulated scenario converges over 25 decibels with respect to the increase in BER rate.

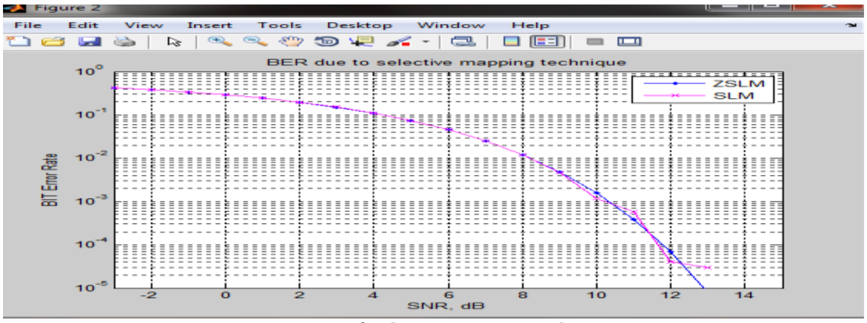

Fig 2: BER of Selective Mapping technique

The figure 2 shows the bit error rate performance of the Selective mapping zero padded technique. The graph displays the comparison output of the selective mapping technique with and without zero padding technique. In zero padded state the signal to noise ratio converges over 12.8 db and without zero padded state the output deviates from 12.8 db. However the bit error rate performance is significantly better compared to spatially modulate zero padding technique.

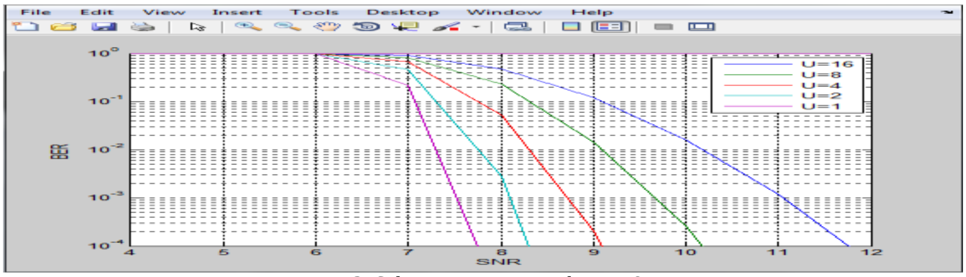

Fig 3: Selective Mapping with N=128

The figure 3 shows the selective mapping output with N=128 subcarriers. Here five numbers of users are compared and the user with minimum power consumption converges first.

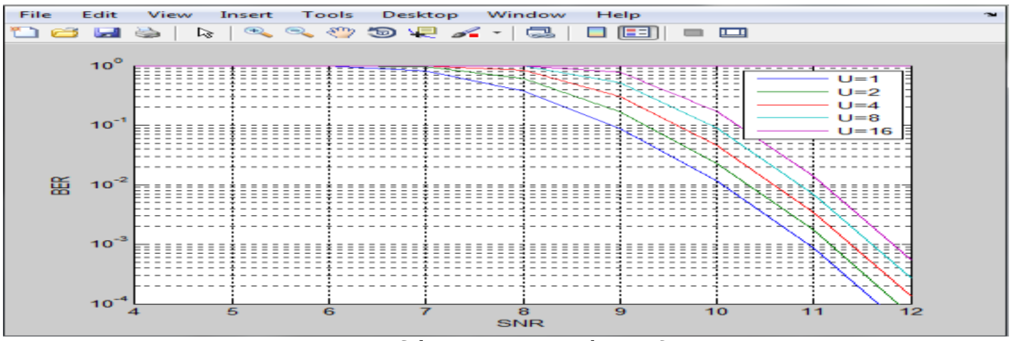

Fig 4: Selective Mapping with N=256

The figure 4 shows the selective mapping output with N=256 subcarriers.Here five number of users are compared and the user with minimum power consumption converges first.

VII. Conclusion

In this paper, method for efficient bit error rate performance has been proposed. This method combines the zero padding criteria along with selective mapping technique using Riemann sequence and discrete cosine matrix transform. The entire scheme consists of discrete cosine matrix transform followed by the selective mapping using Riemann matrix for the phase sequence. The bit error rate performance is evaluated using matlab simulation tool. Experimental result clearly proves that there is a significant improvises in bit error rate performance with very low complexities.

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AUTHOR(S) PROFILE

N.Rajkumar is presently studying M.E second year Communication system engineering in Francis Xavier Engineering College. He has completed his B.E Electronics and Communication Engineering from Rajalakshmi Institute of Technology. His fields of interests are Wireless communication, Digital Electronics and Electronic Devices.

Mr.W.Stalin Jacob is presently working as a Assistant Professor, Department of Electronics and Communication Engineering, Francis Xavier Engineering College, Tirunelveli. He completed his "Electronics and Communication Engineering from Vins Christian College of Engineering, Nagercoil in the year 2008 and M.E in Embedded Systems Technologies from Sun College of Engineering and Technology, Nagercoil. He has 3 years 9 months experience in teaching as Assistant Professor in various colleges. His fields of interest are Embedded system technologies, Wireless Communication and Digital electronics.

G.Sujeetha is presently studying M.E second year Communication System engineering in Infant Jesus College of Engineering and Technology. She has completed her B.E Electronics and Communication Engineering from Francis Xavier Engineering College. Her fields of interest are Digital Electronics, Wireless Communication and Satellite communication.