Applied GIS

ISSN: 1832-5505
Vol-10 Issue-03 July 2022

Performance Improvement through PAPR Reduction in MIMO-OFDM systems using Selective Mapping (SLM) Technique

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ABSTRACT

To improve spectrum efficiency, 5G necessitates the use of highly sophisticated communication protocols. Because of their enhanced performance, Multiple Input Multiple Output (MIMO) along with Orthogonal Frequency Division Multiplexing (OFDM) have beenused. To improve the system's performance, MIMO-OFDM techniques are applied. Because OFDM uses a large number of distinct subcarriers, the signal's amplitude can reach very high peak values. Multicarrier modulation in this form is spectrally efficient. However, the OFDMsignal's strong power peaks result in a high PAPR. This high PAPR raises the BER and lowers system performance.

With varying route numbers, the Selective Mapping Technique (SLM) employing Complementary Cumulative Distribution Function (CCDF) is highlighted in this paper. When the number of subcarriers is large, SLM is effective. In MIMO-OFDM, the SLM technique can effectively minimise the peak to average power ratio. The fundamental issue with SLM isthat it needs bits of side information to discover the actual data bits at the receiver. As SLM with no side information is offered for detection of signal. The simulation results clearly show that PAPR is inversely proportional to the route numbers.

KEYWORDS: MIMO-OFDM, PAPR, Complimentary Cumulative Distribution Function,Selected Mapping.

INTRODUCTION

Higher data speed is becoming a more common demand with each passing day. Enhanced communication transmission techniques have been used to provide high-speed connectivity. MIMO-OFDM is a high-speed communication transmission technology that provides immunity to frequency selective fading, great spectral efficiency and power efficiency for wireless wideband applications such as WLANs, 4G and 5G wideband wireless communications, MIMO-OFDM is primarily used as an air interface. MIMO is a system for enhancing the ability of a radio link with several transmitting and receiving antennas. It is used with OFDM to improve system efficiency. For wideband digital communication, OFDMhas become a popular technology for transporting data over several simultaneous data streams and channels. At a low bit rate, each subcarrier is modulated using a typical modulation approach.The transmitter input bits in MIMO-OFDM are separated into frames of bit. The OFDM signal has a enormous Peak to Average Power Ratio (PAPR), which is a major disadvantage of the MIMO-OFDM system (PAPR). Many strategies for determining the OFDM's PAPR problem can be divided into two categories: 1.Distortion-based techniques and 2.Redundancy-based techniques. By adding up some deformities to the subcarrier signal points, a distortion-based approach lowers PAPR of the OFDM symbol. Both out of band and PAPR can be suppressed with a recursive clipping and filtering procedure. Tone injection (TI), selective mapping (SLM), and partial transmit coding are illustrations of redundancy- based coding (PTS). Different alternatives for lowering the PAPR are there, however either the complexity or redundancy are considerable, or the PAPR improvements are minor. SLM outperforms PTS in terms of data vectors, despite the fact that their profits are equal. PTS complexity improves with number of sub-blocks. SLM is the most advantageous approach of all because it is easy to adopt, doesn't cause any abnormalities to the signal transmitted, and that reduces PAPR to a satisfactory level.

blocks is then obtained using IFFT, with x^u expressing candidate signals. Finally, for transmission, the signal with the lowest PAPR is chosen, as shown in figure 1.

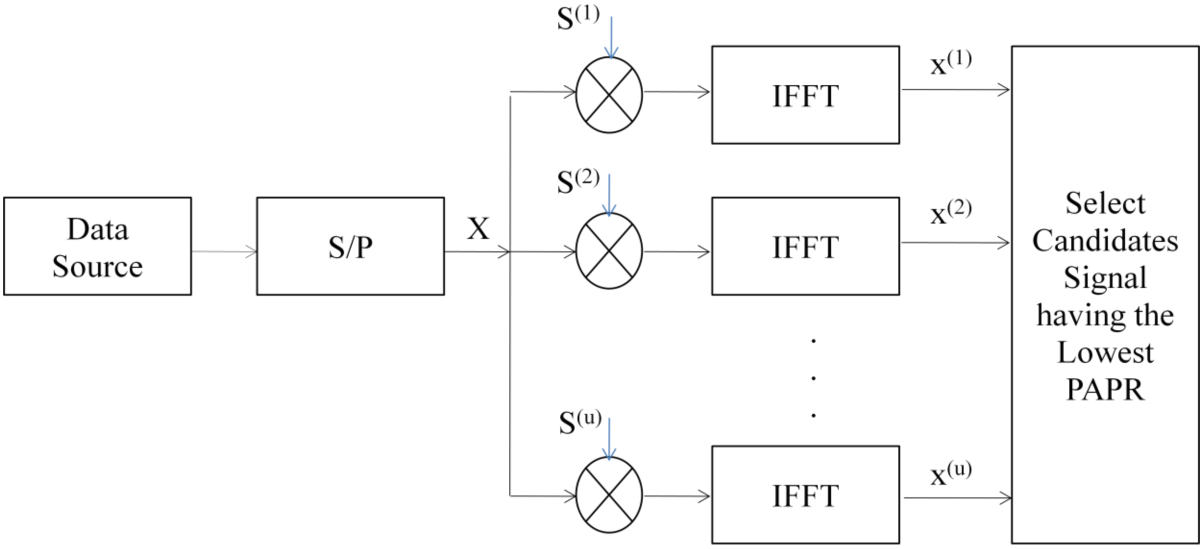

Figure 1: Block diagram of Selected Mapping (SLM) technique

The receiver needs side information in order to correctly recuperate the received signals. When binary bits are employed, $[\log_2 S]$ bits are sufficient to describe this side information. With the sending signal, the side information is made available.

SLM can be applied to any signal constellation with any number of sub-carriers. With moderate complexity, it gives substantial improvement. To maintain side information, channel coding is required. After executing the dot product, it is important to determine which sequence is related to the shortest PAPR with M distinct candidates at the receiver in order to demodulate the incoming signal precisely. As a result, the information that must be learned by receiver about the specified sequence of phase vector P_m and verify that it is accurately received.

An appealing technique is to send the branch number m's entire sequence to the receiving end as side information. In practise, however, the operation does not always necessitate the delivery of the complete vector sequence. It can be accomplished instead by providing the vector sequence's route number. This is only conceivable if the receiving end can use a look-up table or another way to re-establish the random phase sequence P_m. Channel coding is utilised to ensure a reliable communication because side information is critical in order to restore the signal at receiver's end. Once channel coding technique is offered, any additional side information is not essential, throughout the transmission process. All alternative paths are discovered in this way, and the most likely one is chosen as the best, at the receiving end.

SIMULATION OF SLM SCHEME

Using Matlab, an assessment of parameters that may influence PAPR reduction performance is carried out in this paper. According to the fundamentals of the SLM algorithm, the M, route number and N, subcarrier number has an impact on the effectiveness of SLM to reduce PAPR. As a result, simulations with various M and N values will be carriedout, with the results revealing certain desirable features of signals expressing the same information.

Parameter	Value/Description
No. of random data bits	10000
Modulation Technique	QPSK
Over Sampling factor (Case 1)	8
Route Number (M) (Case 1)	4, 8, 16 & 32
Route Number (M) (Case 2)	8
Number of Subcarriers (N) (Case 2)	32, 64, 128 & 256

Table 1: Important Parameters used for the simulation of SLM scheme

Case 1: Analysis of PAPR reduction performance with various M values when N is kept constantat 128. Define

To begin, the rotation factor is described as $S_{m,\,n} \in \left[\pm 1, \pm j\right]$ from the standpoints of intricacy and practicability. When compared to conducting miscellaneous complex multiplication, this drastically reduces computation complexity. The process is repeated 10000 times, with anusing a QPSK mapping modulation technique for each sub-carrier and an over-sampling ratio of 8. The parameters utilised as route numbers are M=4, M=8, M=16, and M=32. Figure 2 shows that the suggested SLM method reduces PAPR more effectively than the real OFDM signal, which is unaffected by the PAPR control scheme.

The likelihood of a substantial PAPR is substantially diminished. Raising M enhances PAPR reduction performance. Comparing CCDF curves with different M values is possible with a chance of 1%. For example M=4, the PAPR value is around 2 dB lower than for case M=1. Under identical circumstances, the PAPR value for case M=32 is about 3 dB lower than case M=1. Nevertheless, comparing the curves for M=16 and M=32 reveals that the performance gap between the two would be smaller than 0.5 dB. This demonstrates that the performance of OFDM signal PAPR reduction will not be much enhanced, and that raising the value of M (for example, to M>=8) will not lead to a linear improvement. Furthermore, it is evident that the execution time will grow in proportion to the value of M. Since this enhances system performance and prevents adding too much computational complexity, we are able to effectively save precious resources when we employ M=8 in practice.

Figure 2: Comparison of PAPR reduction performances with different values of *M.*

Case 2: Analysis of PAPR reduction capability with various N values, while M is kept constant at 8.

In this situation, the number of OFDM signal frames M is set to 8 and the number of sub-carriers N is set to 256, 128, 64, and 32, respectively. Figure 3 shows the CCDF curve of the original sequence's PAPR as a point of comparison to those who used the SLM technique.

Even though the number of carriers doubled after the adoption of the SLM method, the PAPR reduction performance of OFDM signal is not significantly reduced when the total number of sub-carriers exceeds 128, as shown in Figure 3.

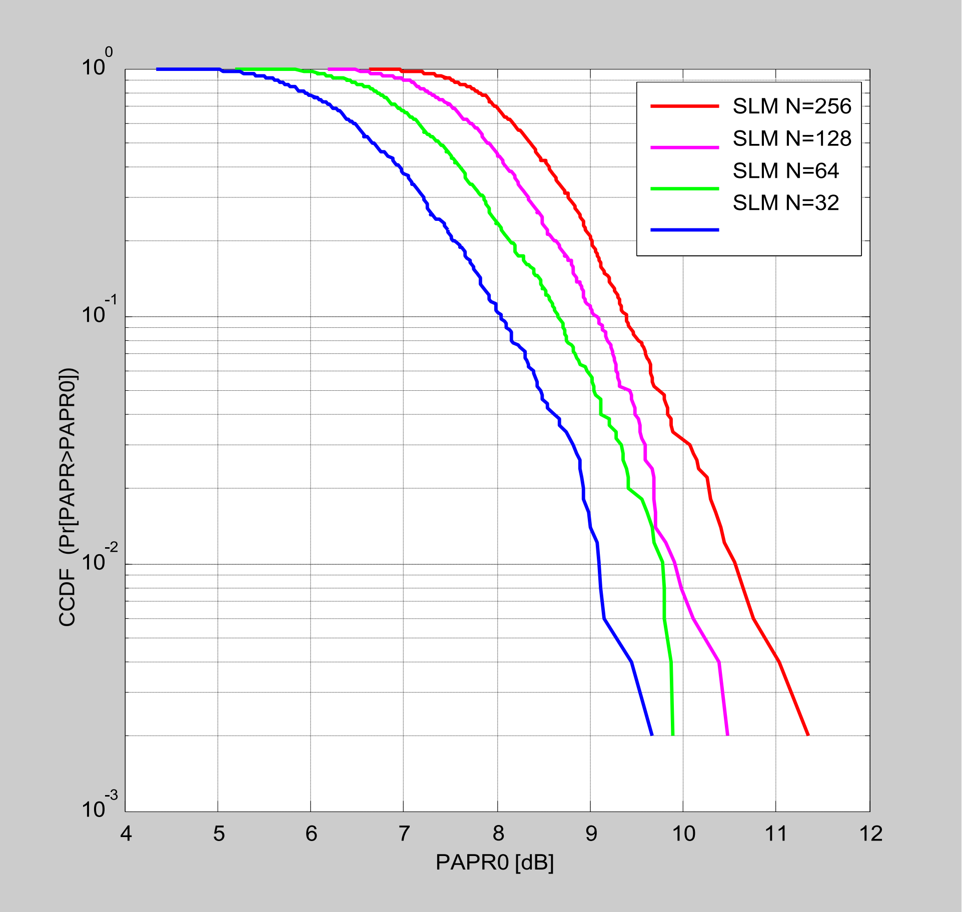

Figure 3: Comparison of PAPR reduction capability with various N values.

CONCLUSION

The results of comparing and evaluating the aforementioned forms of simulation data led to these conclusions:

1. An OFDM system's PAPR distribution is greatly enhanced by the SLM approach, which lowers the probability of displaying a high peak power signal. Increasing the amount of OFDM signal frames is strongly advised. in an effort to increase complexity while improving PAPR reduction capabilities to a certain extent.
2. OFDM systems with varying carrier counts may make advantage of the SLM approach due to its adaptability, which allows it to be applied to FFT frames of any length. This method is recommended for

OFDM systems with more than 128 sub-carriers.

3. By successfully reducing the PAPR, the SLM approach significantly enhances the performance of an OFDM system. Having said that, its price tag and intricate design are obvious. The SLM approach requires the transmitter to always calculate M group IFFTs, as opposed to only one group IFFT as is typical in OFDM systems. IFFT is made of of Tackling these problems and making OFDM practicable for real-world deployments requires reducing the computational complexity. Based on this, we may say that M=8 is an optimal compromise between theoretical computer complexity and practical performance.

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