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Reduction of PAPR and improved BER using SLM technique

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Abstract: With the introduction of 5G wireless technology, mankind has achieved a massive leap in data throughput of gigabits per second thanks to the combination of multiple input, multiple output, and orthogonal frequency division multiplexing technologies. Multiple (OFDM MIMO) can be achieved via frequency selective fading. PAPR (Peak-to-Average Power Ratio) is one of the most crucial performance concerns, since it makes OFDM particularly prone to harmonic distortion, reducing channel estimate accuracy and resulting in a lower bit error rate (BER). In the MIMO-OFDM system, we present a selective codeword shift mapping approach (SCS-SLM). It lowers the PAPR and forces the power amplifier to operate in the non-linear region, resulting in sub-carrier intermodulation, signal constellation, bit error rate distortion, and improved system performance. Additionally, using orthogonal frequency division multiplexing with space-time-frequency block code (STFBC OFDM) may increase BER performance. Selective Mapping is mentioned in this research as an effective approach for reducing PAPR. Furthermore, the bit error rate performance of this system is reviewed, as well as the process complexity as a result. A complete examination of the mutual independence of the alternative OFDM signals generated using this technique is also discussed, in addition to the previously mentioned analysis. Furthermore, the superfluous bits on the side of the transmitted OFDM signal are removed with this new technique.
Keywords: (peak-average power ratio (PAPR), Multiple-input, multiple-output & orthogonal frequency-division multiplexing (MIMO-OFDM), space-time frequency block codes (STFBC), Selective Codeword Shift Selective mapping (SCS-SLM).

I. INTRODUCTION

In the correspondence framework, the transmitted signals are difficult to receive at the receiver because of diffraction, reflection, and dispersion caused by structures, such as mountains, which block the line-of-sight path (LOS). Simply said, if there is an occurrence of obstructive LOS, the received signals can return from completely unanticipated directions, and this is referred to as multipath engendering (Frequency Selective Channel). Orthogonal frequency-division multiplexing (OFDM) is a type of multicarrier modulation (MCM) in which data is transmitted via a number of lower-rate subcarriers. One of OFDM's primary advantages is its resistance to channel dispersion, as well as its simple half and channel estimation in a highly time- varying environment. OFDM has succeeded in a wide range of RF domain applications, from digital audio/video broadcasting (DAB/DVB) to wireless native area networks, thanks to the evolution of strong semiconductor DSP technology (LANs). However, OFDM has inherent drawbacks, including a high peak-to-average power ratio (PAPR) and sensitivity to frequency and phase noise.As a result, for study into its applications in the burgeoning field of optical OFDM, a solid understanding of OFDM foundations is necessary. Due to the inclusion of subcarriers, the tallness force in Orthogonal Frequency Division Multiplexing (OFDM) can be much more than the conventional force, resulting in an unusually large peak to average power ratio (PAPR). PAPR could be a significant concern inside the correspondence system because of its severe influence on the delivered signal. High PAPR causes signal tops to enter the non-linear area of the RF power amplifier, lowering the RF power amplifier's strength. Low PAPR permits communication power electrical equipment to perform properly. PAPR is caused by a large number of independently modulated subcarriers. As a result, before transmitting the signal, we must lower its high peak amplitude. When PAPR is low, the transmitting power amplifier functions well; however, when PAPR is high, the signal peaks shift into the RF power amplifier's nonlinear area, reducing the RF power amplifier's efficiency. The OFDM system, however, has a high PAPR, which is one of its main drawbacks.There are many different forms of PAPR reduction approaches, but they are all categorized into four main categories: Signal

A. Distortion Techniques

Probabilistic Techniques and Multiple Signaling
Coding Methodologies
Hybrid Methodologies

The Selected Mapping (SLM) technique receives the most attention in this project of all the techniques. This technique has been put through three rounds of assessment. One of them is the method for avoiding the transmission of additional data while using the OFDM sign in the manner described in the phase avoiding the SI index Transmission. Another part of this method that requires consideration is how to reduce processing complexity. In the final critical evaluation, the mutual independence of the opportunity segment vectors used in this approach will be approximated.

II. LITERATURE SURVEY

To predict, measure, and validate the performance of a mobile wireless network, any simulation tool can be utilized. These tools are reliable and provide a good combination of precision and complexity. Moreover, because data may be logged at key points and utilized to study system protocols, simulation results are easier to interpret. This equipment limits a variety of analytical techniques, commercial simulation tools, and experiments. MATLAB is often regarded as the most effective tool for simulating any system that can be represented mathematically. MATLAB has the potential to be a great tool for technical computing. It combines computing, visualization, and a programming environment into one package. MATLAB is also a popular programming language environment because of its complex knowledge structures, built-in writing and debugging tools, and support for object-oriented programming. These features make MATLAB an excellent teaching and research tool. When it comes to solving technological difficulties, MATLAB has various advantages over traditional laptop languages (e.g., C, FORTRAN). It is designed for both numerical and symbolic computation. It's an application-oriented programming language that's primarily applied in engineering and scientific computing. This operates in a Desktop environment, offering a wide range of choices for unrestricted exploration, creativity, and problem-solving. With the help of the built-in Graphics, create custom plots for visualising information and tools. Specific applications are created to solve a specific set of issues, such as data classification, system design and tuning, and signal analysis. Many add-on toolboxes are available to help you build a wide range of engineering, scientific, and custom programme applications.

As per the thesis presented by T. Gayathri and K. Bavithra, "Peak to average power ratio reduction of OFDM system," *International Conference on Information Communication and Embedded Systems (ICICES2014)*. “A novel SI detection method enabling low complexity data decoding is proposed. Simulation results of this proposed SI detection method shows the bit error rate performance comparable to that of the simplified maximum likelihood data decoding scheme while the computational complexity is close to that of the embedded SI based data decoding scheme.”

And after through "An improved technique to reduce peak to average power ratio in OFDM systems using gold/Hadamard codes with selective mapping," *2014 International Conference on Signal Processing and Communications (SPCOM)*, 2014 by A. S. Namitha and S. M. Sameer. They say SLM is one of the most efficient without causing any signal distortion commercial or free.

A. Identification of PAPR Problem

The Multicarrier method is thought to be a genuine advancement in wireless communication systems, with OFDM being the most significant. The high PAPR with reference to achieve power efficiency is a significant disadvantage of OFDM. To counter reduced power productivity, using large dynamic range DACs, as well as less expensive HPA and linear range converters, increases equipment costs while also increasing system complexity. To reduce equipment costs, it has become necessary to employ effective PAPR reduction methods. The disadvantage of employing a large dynamic range is that it has an impact on component design. For example, the length of the FFT/IFFT, mixer stage, and HPA, which was designed to deal with the ADC and DAC's irregularity Noise ratio (SQNR). On the basis, the issue of PAPR is more important in the uplink system. Because the mobile terminal's battery power is limited in the uplink, the uplink transmission's feasibility of a power amplifier is important. It's tough to build components with a wide enough linear range to reach the HPA's saturation point. Increased BER or spectral splatter causes adjacent channel interference, whereas saturation causes both in-band and out-band distortion. To cope with the problem of designing such components that work within a vast linear range, it is reasonable to do so because the components will work incorrectly, and the cost will be too expensive.

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This is especially the case in the HPA, where there is a large cost and half the size of the transmitter. High output power efficiency is achieved by operating HPAs close to the saturation range. When the data on the subcarriers is accumulated in a constructive way at the transmitter side, a high PAPR is achieved. Due to their restricted dynamic range, the DAC and power amplifier could clip the composite broadcast signal. A significant amount of distortion occurs because of clipping.

B. Proposed SLM Technique

For OFDM signals, selective mapping is a simple PAPR suppression technique. The SLM technique is primarily based on the concept of symbol scrambling. This system generates a group of candidate signals to represent similar information, then selects the signal with the lowest PAPR for transmission. As side information, the information regarding the selection of these candidate signals must be explicitly communicated along with the selected signal. The information must be transmitted to the receiver as side information using the selected mapping technique and the selected signal. If the received data has any errors, the receiver will have a great difficulty in recovering the data from the transmitted selected signal. As a result of this flaw, a strong security of side information is required. If the receiver has this side information, decoding becomes incredibly straightforward. The SLM PAPR reduction approach can support a wider range of sub-carriers of moderate complexity.

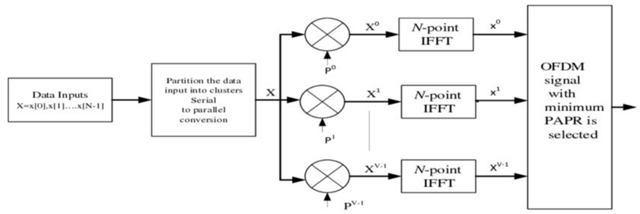

Fig-1: Conventional SLM Technique

The SLM technique generates several duplicate signals from a single input signal, each of which reflects the original data. This signal duplication is multiplied by some rotation factors. The multiplication factors are phase rotation factors, and IFFT modulates the afterwards signals. After then, the signal with the lowest PAPR is sent. The rotation vectors provide as side data that enhances signal recovery. This is the main drawback of the traditional SLM technique, as it adds another component to get a low PAPR. The efficiency of the system is determined by the amount of scrambling done by rotation factors on the first OFDM sequence and the length of SLM. The approach just includes codes for reducing PAPR and does not include error correction. Due to the varying amount of IFFT operations, the complexity is increased. Under fading channels, the requirement for transmitting side information to the receiver with no margin for transmission errors is important. Various duplicate signals are designed to enhance the original data in this process, and the signal with the lowest PAPR is selected at the transmitter side. The OFDM system's selective mapping (SLM) technique is an effective PAPR reduction technique. The basic principle of SLM is to provide different transmit sequences from the same data source in order to select the transmit signal with the lowest PAPR. Because the PAPR is determined by the sequence of transmit data vectors, Xm multiplying the info vectors by some random component can change the PAPR qualities when the IFFT is performed.

III. BLOCK DIAGRAM

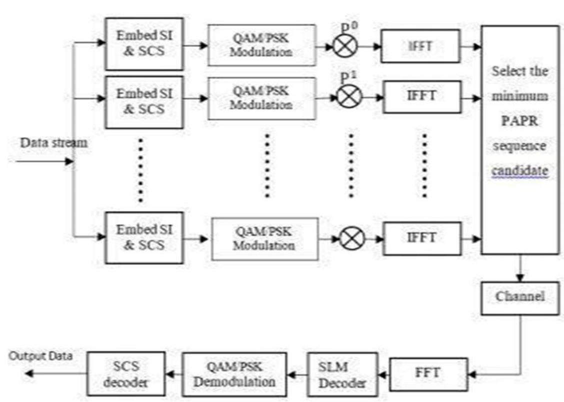

Fig-2: Block Diagram of Proposed SLM –OFDM system

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IV. METHODOLOGY

The Selective Mapping method's calculation is as follows:

1) Split the input data into a number of subblocks and use a convertor to convert them into a parallel structure.
2) To generate an input symbol sequence, the input data sequences are multiplied by phase sequence.
3) Each input symbol sequence is subjected to an IFFT operation.
4) Determine the resulting signal's CCDF and compare it to the threshold value.
5) For transmission, data with the lowest PAPR is selected.

SLM is a form of phase rotation method in which the phase rotated data with the lowest PAPR is chosen for transmission.

PAPR has a probability larger than a threshold value z, which can be expressed as

$(PAPR > z) = 1 - (1 - \exp -z) N$

Assume M OFDM symbols each contain the same data and are linearly independent of one another. In this situation, the chance of PAPR being greater than z is equal to the product of the probabilities of each independent candidate. This process can be written as

$P\ PAPRlow > z = (P \quad PAPR > Z)\ M = ((1 - \exp -z)\ N)M$

In this SLM technique, M statically independent sequences expressing the same information are produced first, and then the resultant M statically independent data blocks

Sm= (Sm, 0, Sm, 1, Sm, N1) T, m= 1,2, M

are concurrently sent through the IFFT process. At the end of the reception phase, the OFDM symbol Xm = (x1, x2, … xN) T in discrete time-domain is received, and the PAPR of these M vectors is computed separately. The sequences xd with the lowest PAPR will eventually be chosen for final serial transmission. This technique can increase the PAPR performance of an OFDM system considerably.

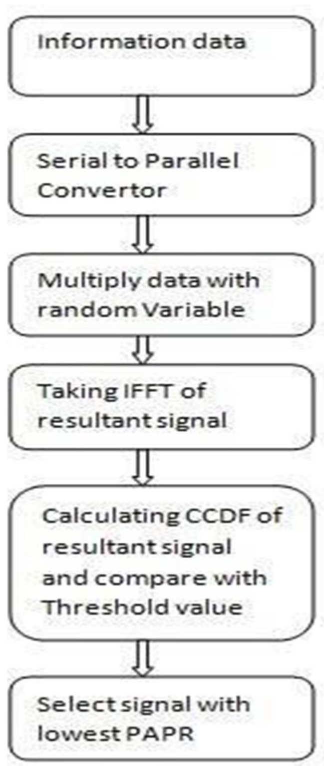


Fig-3: Flow chart of SLM technique

V. IMPLEMENTATION

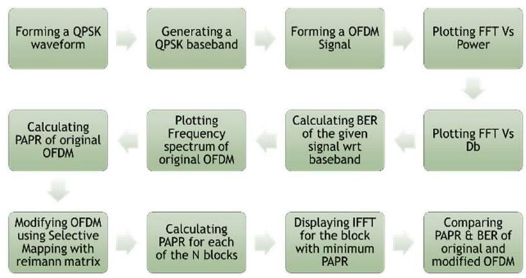


Fig-4: Simulation Methodology

A. To create a signal and modulate it using qpsk.

B. Forming an OFDM signal in OFDM system.

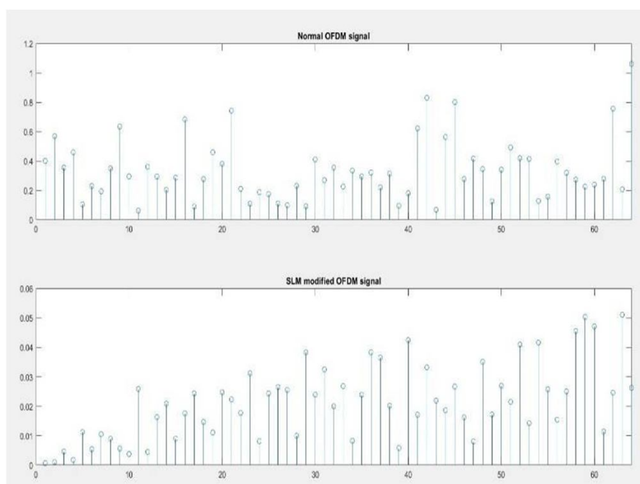
C. To calculate BER for randomly generated numbers.

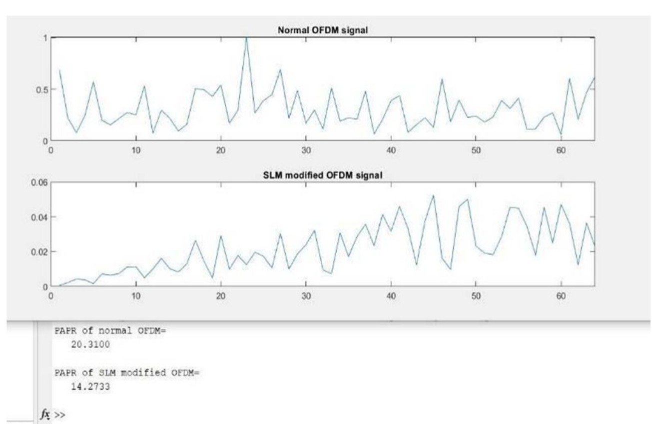
D. To calculate BER for qpsk and qam modulation.

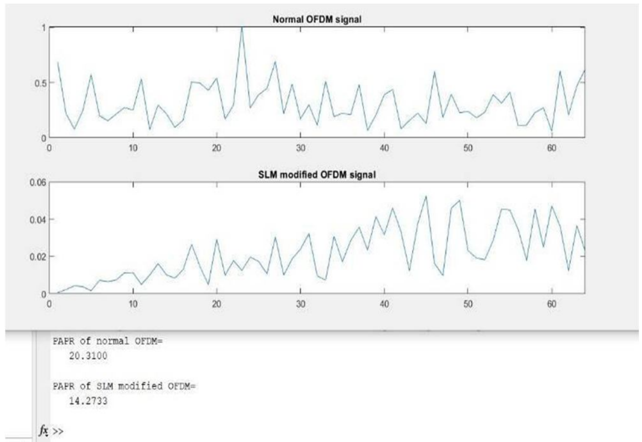
E. Calculate frequency spectrum.

F. OFDM signal with SLM technique will be received at the output with low PAPR.

VI. RESULTS AND OUTPUTS







VI. FUTURE WORK AND CONCLUSION

We constructed an OFDM signal and calculated the BER of various modulation techniques, including QPSK and QAM. We also used the SLM method, which enhanced the efficiency of the OFDM system by 24 percent while lowering the PAPR. This code can be used to generate OFDM with various values. For more hands-on experience, we're currently constructing an SLM modified OFDM signal in Simulink. We have completed the construction of a QPSK-modified OFDM system. We can get all of the essential outputs on the display itself in this way. We can run the system to find efficiency in a more practical manner once we implement the SLM.

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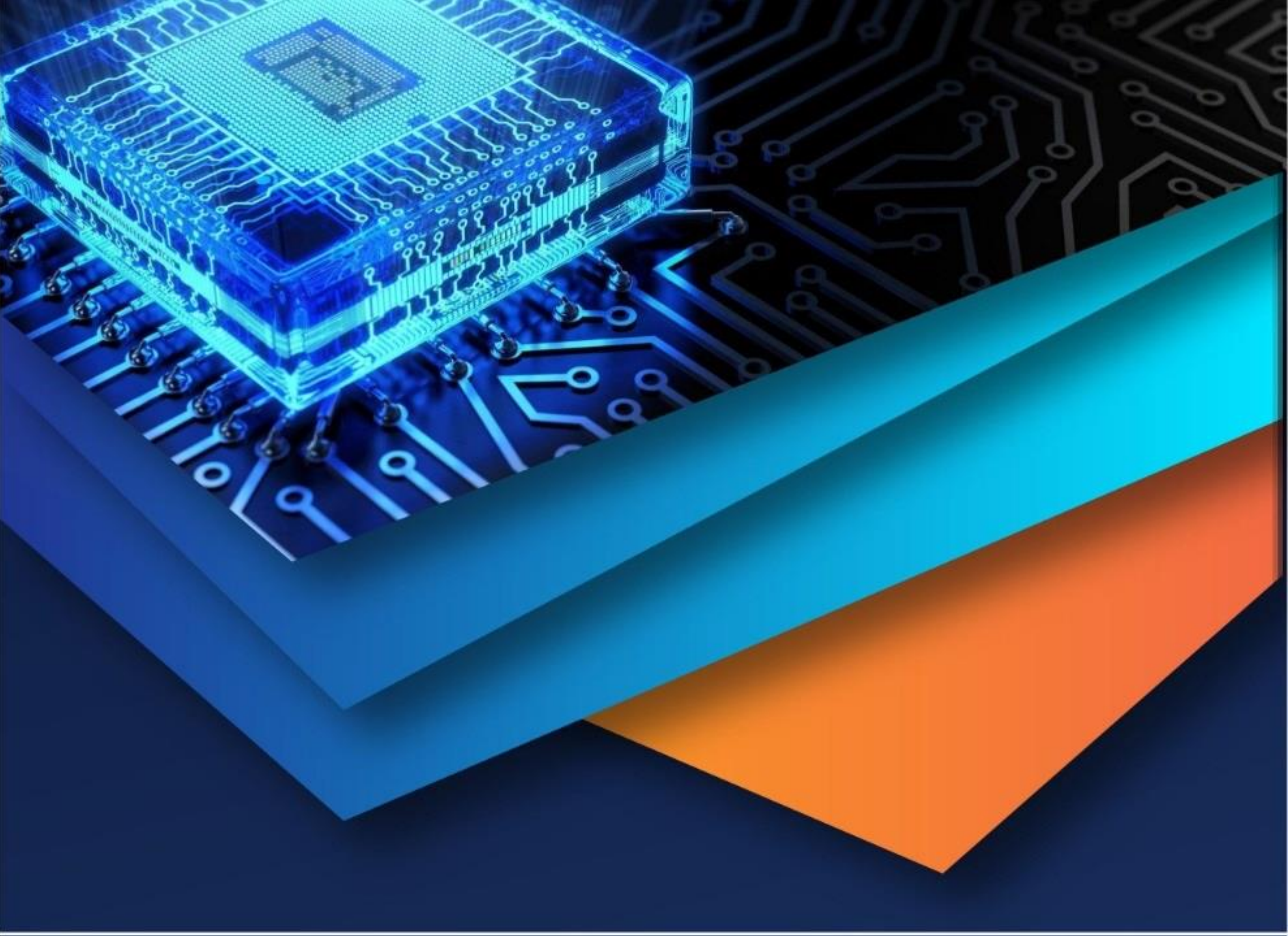

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