"A Hybrid PAPR Reduction Technique for Performance Enhancement of OFDM System"

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Abstract: In the Present world, communication is the basic thing we all need. As the demands in communication are increasing, the growth in this field is also increasing at a rapid rate. For improved transmission of the data, multi-carrier waves replaces the single carrier waves. For the transmission of multicarrier waves, Code Division Multiple access (CDMA) and Orthogonal frequency division multiplexing (OFDM) techniques are used commonly. OFDM is an effective technique for the transmission of the data at high speed. In OFDM systems, carriers which are placed orthogonally are used to transmit the data from transmitter to receiver. In OFDM Systems, various problems occur like Inter symbol Interference, Inter-carrier Interference, Noise problem, Peak to average power ratio (PAPR) problem. In this paper, our main focus is on the PAPR problem as it is the major drawback of the OFDM systems. In OFDM, large number of independent sub carriers are contained which results in high peak values of the amplitudes of such signals. There are number of PAPR reduction techniques to reduce the good value of PAPR so that our system work more efficiently. In this paper a new approach of Hybrid Technique (Selective Mapping and Modified Clipping) is proposed.

Keywords: OFDM, PAPR, SLM.

I. INTRODUCTION

OFDM stands for Orthogonal Frequency Division Multiplexing. This technique is a multicarrier modulation technique for fourth generation wireless communication systems. This technique is implemented widely for high rate data transmissions in Digital subscriber lines (DSL), WiMAX, Wireless Local area Networks (WLAN's), Digital video Broadcasting and many other wireless broadband systems. OFDM uses the principle of serial to parallel transform so that the high data rate stream is assigned on some relative low data rate parallel and orthogonal sub-channels [6]. As the transmission data rate is low, the period to transmit one data symbol is inflamed and the effect of fading and multi-path is reduced on OFDM system performance. With OFDM, the major problem is with PAPR. In OFDM, the non-linear effects are increased due to the large number of sub carriers which results in the high PAPR value. So there is a necessity for the reduction of the PAPR in OFDM [10]. There are various techniques like Clipping, Selective Mapping, Partial Time sequence, Tone reservation technique and many others to reduce a good value of PAPR. Among all the techniques Selective Mapping Technique is an attractive solution due to its good performance. This paper introduces the combination of Selective Mapping and Modified Clipping Technique.

II. HIGH PAPR PROBLEM

PAPR stands for Peak to average power ratio. PAPR is the major problem in OFDM system. It is the ratio of maximum power of a sample in an OFDM transit symbol to the average power of that OFDM Symbol. PAPR occurs when different sub-carriers are out of phase with each other in a multi-carrier system. The peak value of the system can be very high as compared to average value of the whole because of the occurrence of large number of individually moderated sub-carriers in an OFDM System. Also with high value of PAPR, the effectiveness of the RF amplifiers is reduced. In this paper, our main emphasis is on the reduction of the PAPR with various techniques so to increase the effectiveness of the OFDM system.

$$PAPR = \max [x(t)]^2 / E[x(t)^2]$$

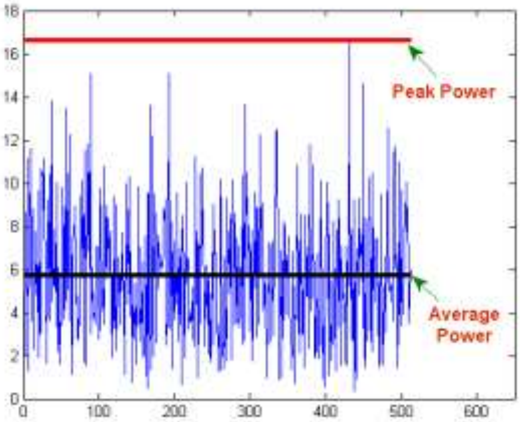


Figure 1: Representation of PAPR

III. PAPR REDUCTION TECHNIQUES

To reduce the PAPR, there are various dependent factors like complexity, increase of power in transmitted signal and also increase in bit error rate at the receiver end. As we discussed earlier, there are various PAPR reduction techniques. In this paper, a combination of Selective Mapping and Modified Signal clipping is proposed. These two techniques are discussed in detail as below:

1. **Selective mapping (SLM) for PAPR Reduction:**
In this technique, suppose there are N data blocks which are independent. Sn=[Sn,0,Sn,1,….Sn,M-1] , n=1,2,…,N signify the same information and is obtained by multiplying the main sequence with N uncorrelated sequence Pn. Then IDFT taken into process. Then the PAPR value is designed for every vector. For final transmission, symbol having lowest PAPR value is selected. Also it is necessary for receiver to verify that the vector sequence which is received is correct.

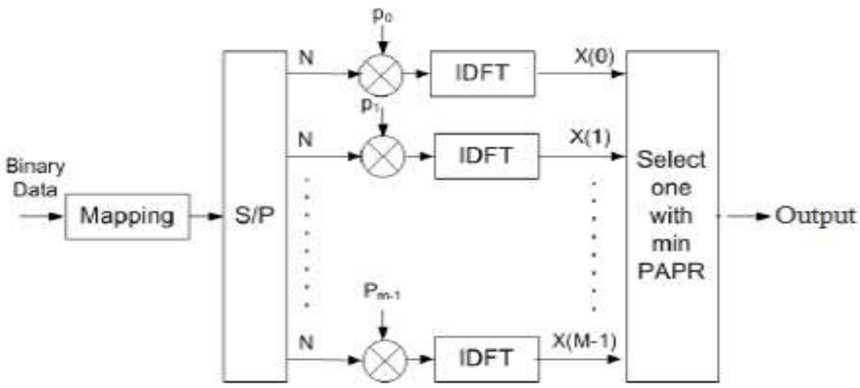


Figure 2: Block diagram of selected mapping Technique [9]

2. **Modified Signal clipping**:
In this technique, we use the amplitude in order to reduce the PAPR value. We define a values of the amplitude which bounds the peak value of the signal. Signal having values higher than this threshold are clipped.

F(x) = { A when x >A,
x when –A<= x >=A
-A when x< -A}

The main problem in this technique is that the clipping of amplitude presents undesired clipping noise. This problem can be solved by repeated filtering and clipping operation.

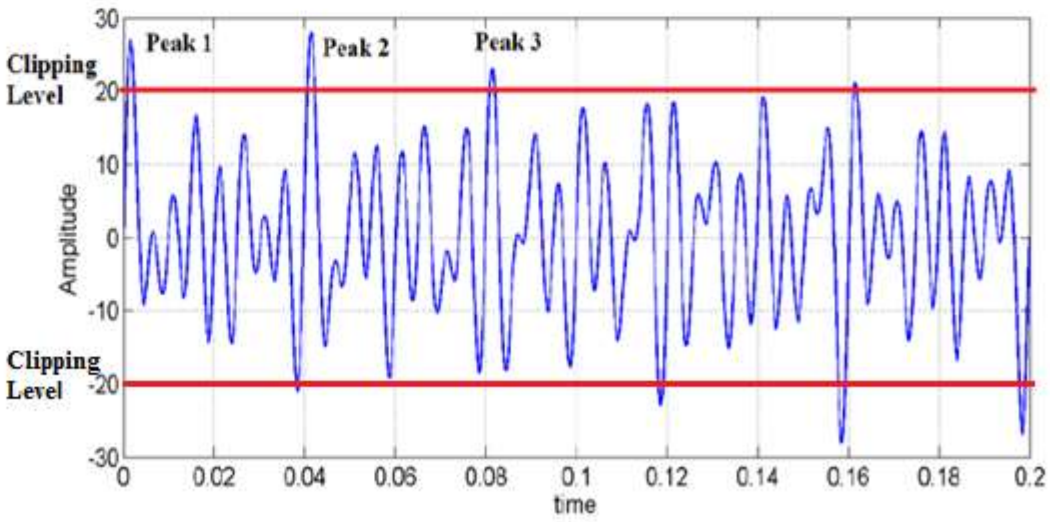


Figure 3: Illustration of Modified Clipping

IV. PROPOSED WORK

A new Hybrid technique which is a combination of Selective Mapping Technique and clipping technique is proposed.

Selective Mapping is an attractive technique because of its good performance of PAPR reduction without any distortion at the transmitting end but the main issue of SLM technique is increase in complexity due to increase in number of sub-blocks and amount of side information to be sent for recovery of original signal.Clipping technique is signal distortion technique which distorts large amount of signal but it reduces the high PAPR

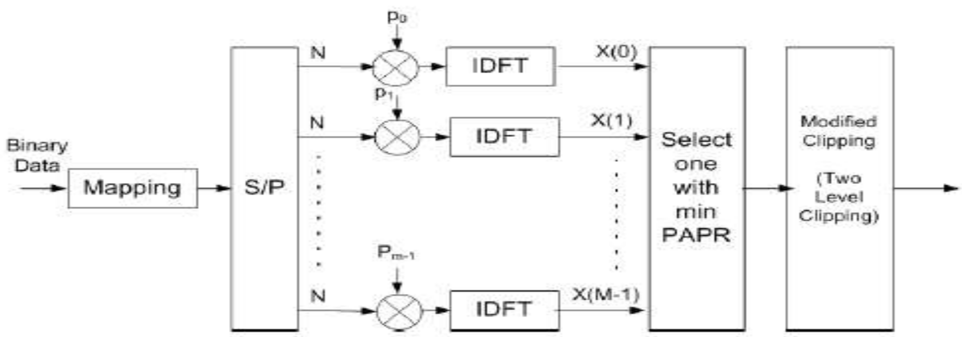


Figure 4: Block Diagram of Proposed Hybrid Technique

Following are the steps involved in Proposed Hybrid Technique**:**

Step 1: The input data will be first modulated with different modulation schemes (BPSK, QPSK, QAM etc.). The signal will be converted into parallel form by passing through serial to parallel conversion.

Step 2: The SLM technique will be applied first and in this technique, frequency vectors are sent to number of sub-blocks.

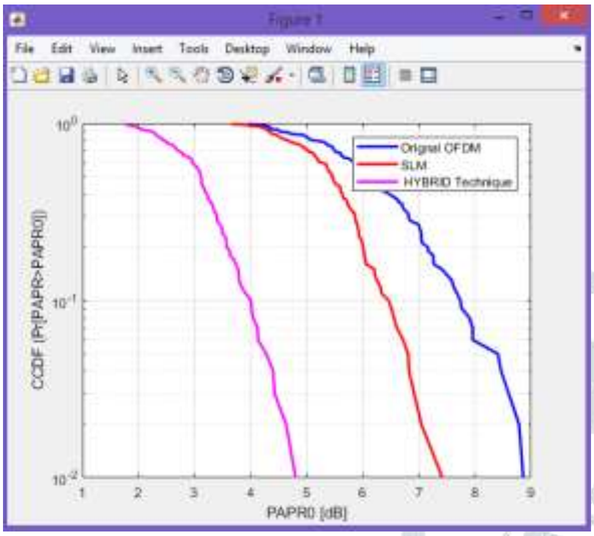
Step 3: Then these vectors will be multiplied by all the possible phase vectors and then IFFT operation will take place for the conversion of frequency domain to time domain signal.

Step 4: Clipping ratios will be selected intelligently so that it does not affect the bit error rate and reduces the high PAPR.

Step 5: With the help of clipping ratios, signal will be clipped. With different sets of obtained phase rotation values, the process will be repeated. PAPR of the OFDM signal will be obtained through each repetition. The lowest PAPR of OFDM signal will be transmitted without much distortion in the signal.

V. SIMULATION RESULTS

The proposed method is simulated on MATLAB. In this section, numerical simulation for original OFDM signal, normal SLM technique and hybrid technique is presented. PAPR reduction performance is evaluated by the CCDF. Simulation uses different modulation scheme (BPSK, QPSK, 16-QAM, 32-QAM), number of sub-blocks L=4, different input data block length (N=64, 128,256) and clipping ratio is 0.7. In order to generate CCDF, 100 OFDM blocks are randomly generated.



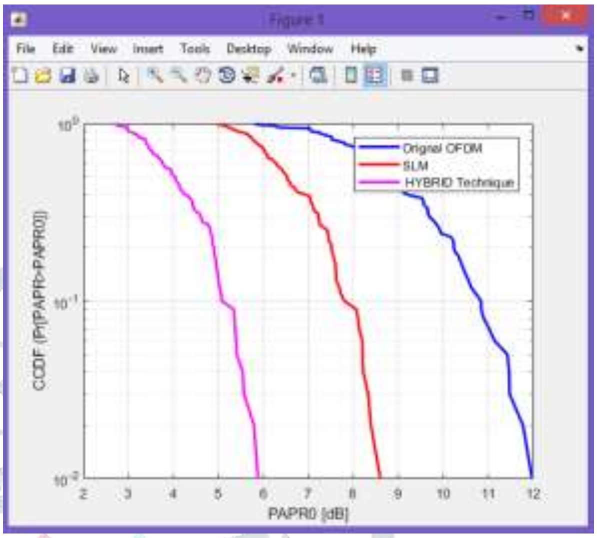
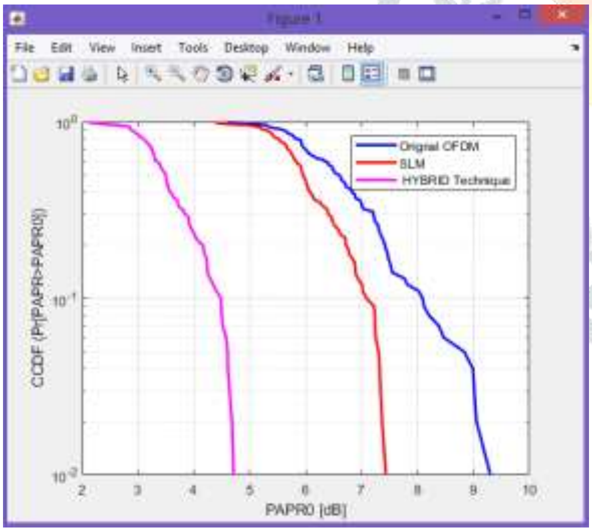


Figure 5: PAPR vs CCDF when N=64 for BPSK Modulation
Figure 6: PAPR vs CCDF when N=64 for QPSK Modulation



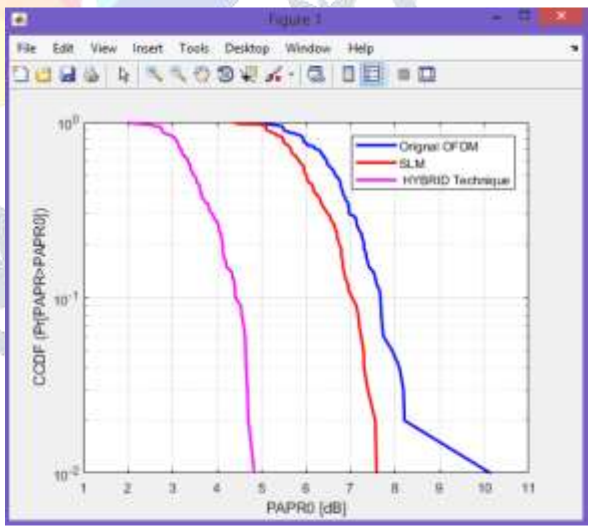
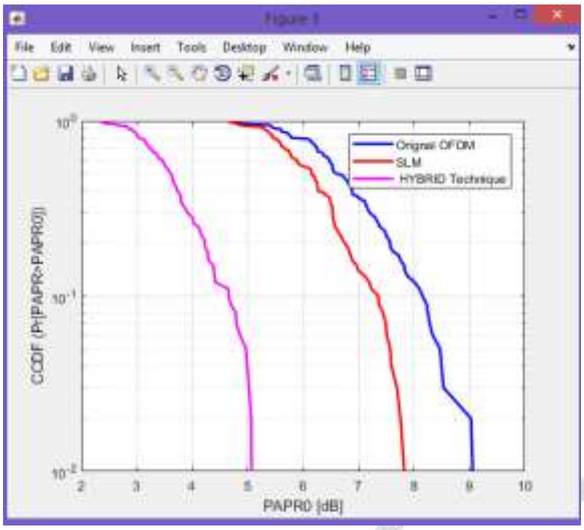


Figure 7: PAPR vs CCDF when N=64 for 16 QAM Modulation
Figure 8: PAPR vs CCDF when N=64 for 32 QAM Modulation

The simulation uses number of subcarriers 64. In Figure 5, for BPSK Modulation PAPR when proposed technique is applied is 4.7 dB while the PAPR of OFDM signal and when SLM technique is used is 8.8 dB and 7.3 dB respectively. In figure 6, PAPR when Proposed technique is applied is 5.8 dB while the PAPR of OFDM signal and PAPR using SLM technique is 12 dB and 8.6 dB respectively as in case of using QPSK Modulation. In Figure 7, when we are applying the 16 QAM Modulation technique, the PAPR when Proposed technique is used is 4.7 dB while the PAPR of OFDM signal and with SLM is 9.3 dB and 7.4 dB respectively.

In figure 8, 32 QAM is applied and the PAPR when proposed technique is applied is 4.8 dB and the PAPR of OFDM signal and when SLM is applied is 10.2 dB and 7.6 dB respectively.



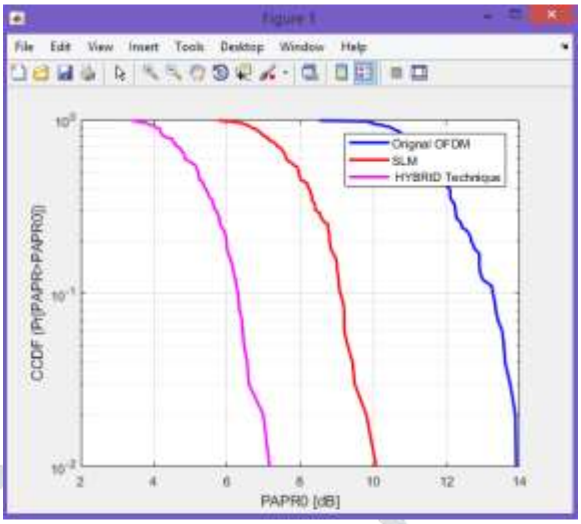
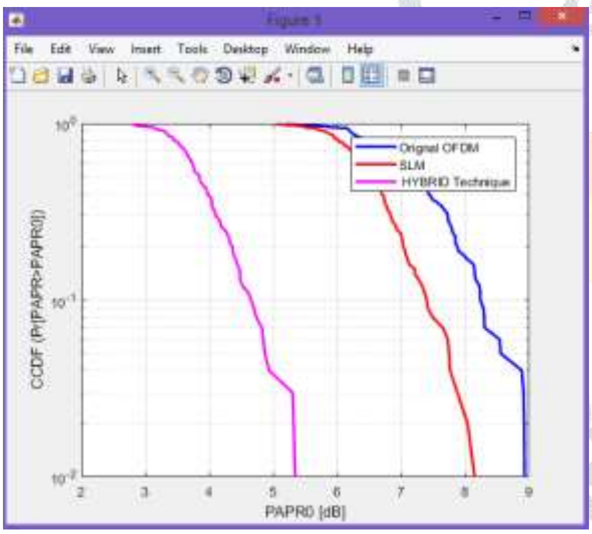


Figure 9 : PAPR vs CCDF when N=128 for BPSK Modulation
Figure 10: PAPR vs CCDF when N=128 for QPSK Modulation



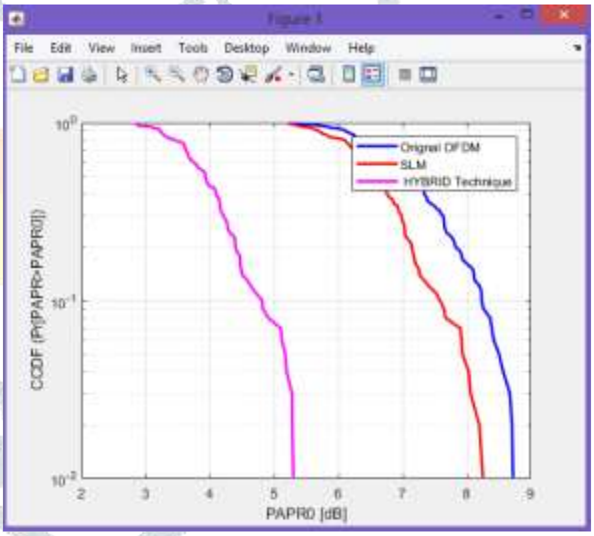
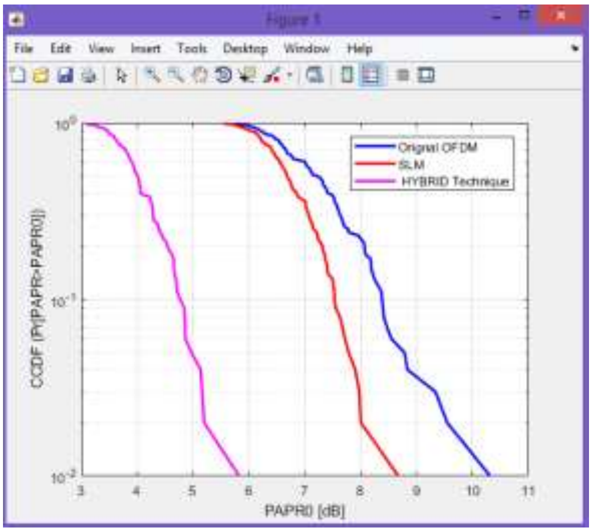


Figure 11: PAPR vs CCDF when N=128 for 16 QAM Modulation
Figure 12: PAPR vs CCDF when N=128 for 32 QAM Modulation

The simulation uses number of subcarriers 128. In Figure 9, for BPSK Modulation PAPR when proposed technique is applied is 5.1 dB while the PAPR of OFDM signal and when SLM technique is used is 9.1 dB and 7.8 dB respectively. In figure 10, PAPR when Proposed technique is applied is 6.6 dB while the PAPR of OFDM signal and PAPR using SLM technique is 12.9 dB and 10.1 dB respectively as in case of using QPSK Modulation. In Figure 11, when we are applying the 16 QAM Modulation technique, the PAPR when Proposed technique is used is 5.3 dB while the PAPR of OFDM signal and with SLM is 8.9 dB and 8.2 dB respectively. In figure 12, 32 QAM is applied and the PAPR when proposed technique is applied is 5.4 dB and the PAPR of OFDM signal and when SLM is applied is 8.8 dB and 8.3 dB respectively.



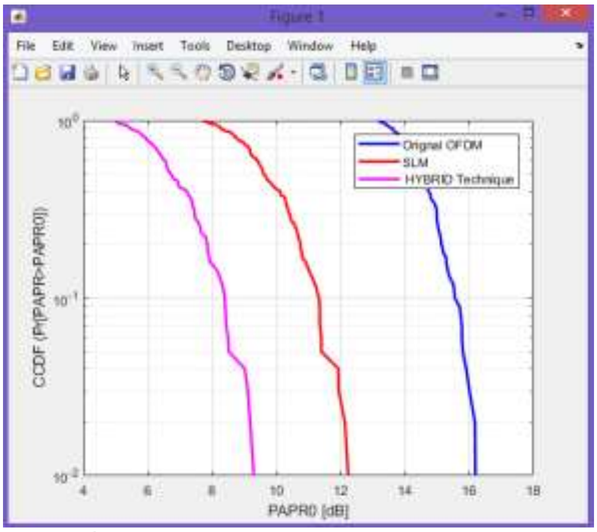
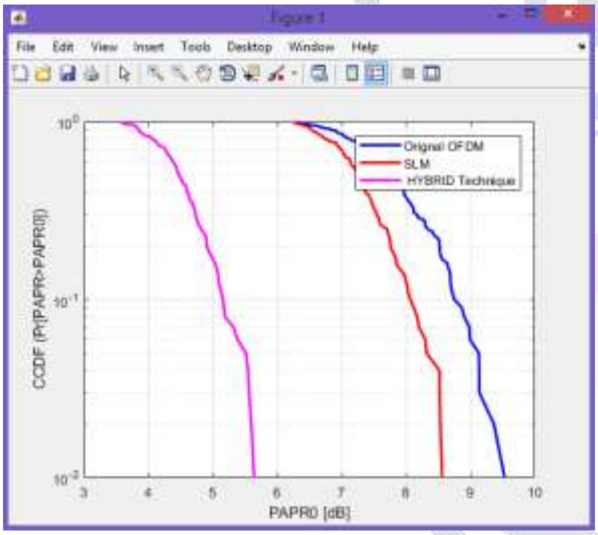


Figure 13 : PAPR vs CCDF when N=256 for BPSK Modulation
Figure 14: PAPR vs CCDF when N=256 for QPSK Modulation



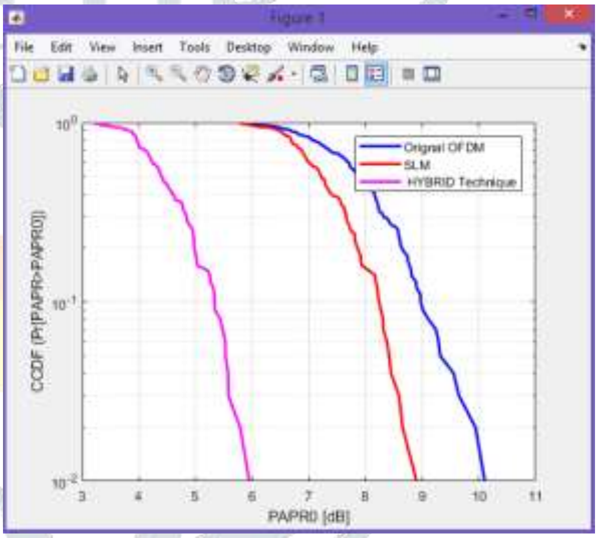


Figure 15: PAPR vs CCDF when N=256 for 16 QAM Modulation
Figure 16: PAPR vs CCDF when N=256 for 32 QAM Modulation

The simulation uses number of subcarriers 256. In Figure 13, for BPSK Modulation PAPR when proposed technique is applied is 5.8 dB while the PAPR of OFDM signal and when SLM technique is used is 10.3 dB and 8.6 dB respectively. In figure 14, PAPR when Proposed technique is applied is 8.6 dB while the PAPR of OFDM signal and PAPR using SLM technique is 16.2 dB and 12.2 dB respectively as in case of using QPSK Modulation. In Figure 15, when we are applying the 16 QAM Modulation technique, the PAPR when Proposed technique is used is 5.6 dB while the PAPR of OFDM signal and with SLM is 9.5 dB and 8.5 dB respectively. In figure 16, 32 QAM is applied and the PAPR when proposed technique is applied is 5.98 dB and the PAPR of OFDM signal and when SLM is applied is 10.1 dB and 8.9 dB respectively.

Size of N	Modulation Scheme	PAPR of OFDM signal(dB)	PAPR when SLM is applied(dB)	PAPR when Proposed technique is applied(dB)

64	BPSK	8.8	7.3	4.7
	QPSK	12	8.6	5.8
	16 QAM	9.3	7.4	4.7
	32 QAM	10.2	7.6	4.8
128	BPSK	9.1	7.8	5.1
	QPSK	12.9	10.1	6.6
	16 QAM	8.9	8.2	5.3
	32 QAM	8.8	8.3	5.4
256	BPSK	10.3	8.6	5.8
	QPSK	16.2	12.2	8.6
	16 QAM	9.5	8.5	5.6
	32 QAM	10.1	8.9	5.98

Table 1: PAPR values with Clipping Ratio 0.7

VI. CONCLUSION

PAPR reduction task in OFDM systems has become a challenging task, and various techniques have been suggested previously to achieve this task. In this paper, we have presented a PAPR reduction scheme by combining the SLM technique with a modified clipping approach. We have evaluated the proposed technique and compared its performance with that of SLM. Simulation results show that the Selective mapping approach improves the PAPR performance. Similarly, the Selective Mapping approach when combined with Modified Clipping scheme is capable of bringing about a further PAPR reduction.

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