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A Low PAPR OFDM System with PTS Technique using SUI 5 Channel

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Abstract: In this paper an outdoor channel model known as SUI Channel with Partial Transmit Sequence is used to reduce PAPR which is major drawback in OFDM system. This method has better transmission performance. It can transmit high data rate signals.The performances in terms of bit error rate (BER) and reduction of PAPR has been investigated by using SUI5 channel model. BPSK and PAM modulation techniques are used for analysing BER performance. The proposed frame work can be simulated in MATLAB R2012a.

Keywords: SUI channel, Partial transmit sequence, BER.

I. INTRODUCTION

Orthogonal Frequency Division multiplexing (OFDM) mainly used in wireless communications. OFDM divides high data rates into many slowly modulated narrow band so as to make less sensitive to frequency selective fading. This is used in latest wireless and telecommunications. OFDM has high data capacity, high spectral efficiency. It has gained a significant presence in the wireless market place. The requirement of OFDM system is that they must be linear. Due to non linearity there is a cause of interference between carriers which results in the inter modulation distortion. In some systems the peaks are limited. Although this introduces distortion resulting in a higher level of data errors, the system can rely on the error correction to remove them. High peak-to-average power ratio (PAPR) is one of the major drawbacks of OFDM. There are many reduction techniques for PAPR. In this paper Partial Transmit Sequence (PTS) technique is used for PAPR reduction. The calculation of PAPR with SUI5 channel using DHT transform and the results are analyzed using two different modulation techniques i.e. PAM and BPSK modulation techniques.

II. OFDM SYSTEM BASED ON DHT

DHT is the extension for FFT. DHT and inverse DHT has the similar equations the same blocks are used at transmitter as well as receiver.DHT/IDHT is faster than DFT/IDFT. It transforms the real inputs to real outputs.DHT is introduced by R.V.L.Hartley in the year 1942. It requires less computation complexity and implementation cost.

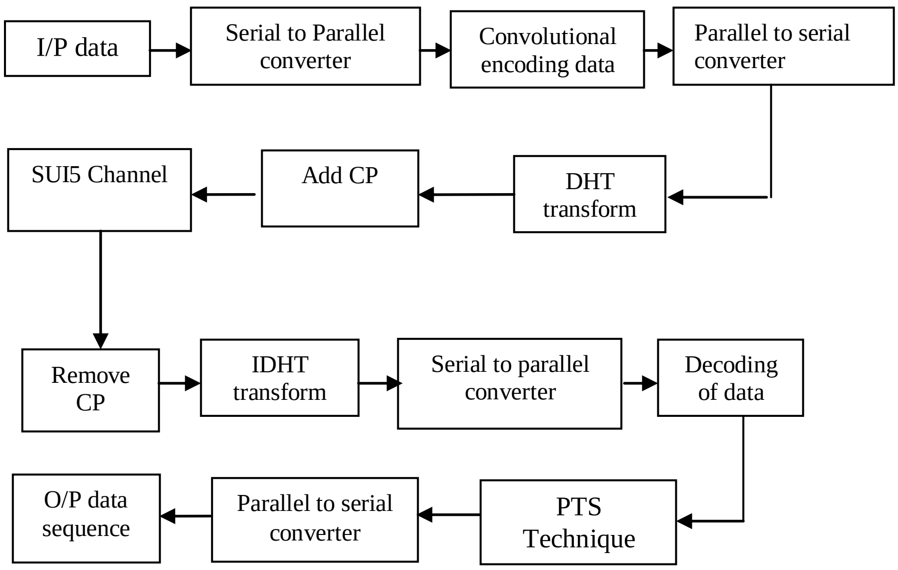

Fig.1: Block diagram OFDM using SUI5 channel

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III. SUI CHANNEL

Standford University Interim Channel is one of channel which is used for outdoor communications. This channel includes different types of parameters such as terrain type, antenna specifications, traffic range, bandwidth etc….This channel is categorized based on some environmental characteristics as follows
Category A: hilly terrain with moderate-to-heavy tree densities, which results in the maximum path loss.
Category B: hilly environment but rare vegetation, or high vegetation but flat terrain. Intermediate path loss condition is typical of this category.
- Category C: mostly flat terrain with light tree densities. It corresponds to minimum path loss conditions.

The general structure of SUI channel can be defined as Input mixing matrix, Tapped delay line and Output mixing matrix. This structure can be generally used for Single Input Single Output (SISO) Single Input multiple Output (SIMO)and also for Multiple Input and Multiple Output(MIMO).
Input Mixing Matrix: It gives the correlation between the input signals when multiple transmitting antennas are used.
Tapped Delay Line: This models multipath fading of channel. A tapped delay line (TDL) is a delay line with at least one "tap". A delay-line tap extracts a signal output from somewhere within the delay line, optionally scales it, and usually sums with other taps for form an output signal. A tap may be interpolating or non-interpolating. A non-interpolating tap extracts the signal at some fixed integer delay relative to the input. Thus, a tap implements a shorter delay line within a larger one.
Output mixing Matrix: It gives the correlation between the output signals when multiple transmitting antennas are used.

Choosing SUI model because of its important characteristics. Some of the important characteristics of SUI channel are as follows:
a) It includes both macroscopic and microscopic fading effects,
b) It considers both co-channel and adjacent channel interference, and
c) It takes account of high multipath delay and Doppler spread.

Path loss calculation in SUI channel can be derived as follows
Path Loss=$D+10\ \beta \log(a/a_0)+Z_c+ Z_b+ W$

Where 'a' is the distance of base station and receiver, 'a_0' is the reference distance, 'Z_c' is frequency correction factor, 'Z_b' is base station height, 'W' is shadowing, 'β' is the path loss component
Where,
$D=20 \log (4\pi a_0/\lambda)$

$W=\log C[0.65(\log C) -1.3+ \alpha/ \log C]$

$Z_c =6 \log(C/2000)$

$Z_b = -10.8 \log (h_a/2000)$

Where 'h_a' height of receiving antenna, 'C' is the frequency of channel
The SUI channel defines a specific power spectral density function which is given as

$$S(f)=\begin{cases} C_0^2[1/ C_0^2-1.72+0.785C_0^2] & |C_0|\leq 1 \\ 0 & |C_0|>1 \end{cases}$$

Where $C_0 =C/C_m$
C_m is the maximum Doppler frequency

IV. PAPR REDUCTION USING PARTIAL TRANSMIT SEQUENCE (PTS)

The major drawback of OFDM system is high PAPR. To reduce this PAPR there are many different techniques such as block coding method, selective mapping technique ,Partial transmit sequence, tone injection, tone reservation technique etc….In all of this technique Partial transit technique is mostly used because it has good PAPR reduction performance and there is no restriction for subcarriers.
In this PTS technique the obtained input data is divided into no. of sub blocks .Sub block is multiplied by phase factor. All these sub blocks are combined to form OFDM signal. In this the main objective is to is to have an optimal phase factor for a sub block. By using this PAPR can be significantly reduced.

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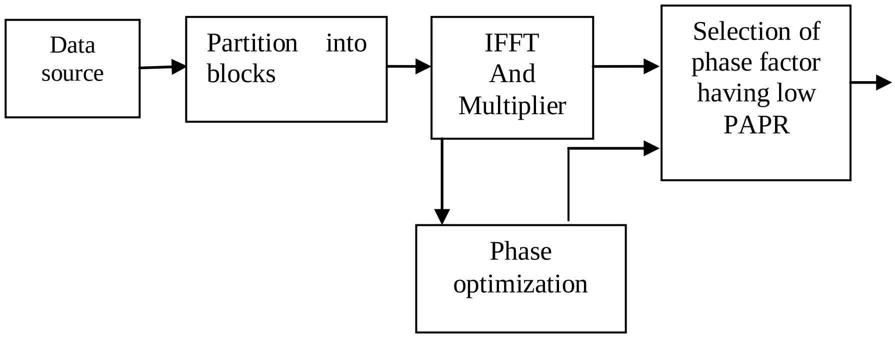

Fig.2: Block diagram of PTS technique

V. SIMULATION RESULTS

The Following are the results obtained by using SUI 5 channel and the calculation of PAPR are done using partial transmit sequence technique. Figure 3 gives the information about the delay profile of SUI5 channel. This output provides information of channel gain with respect to delay time. As the time delay increases channel gain decreases.

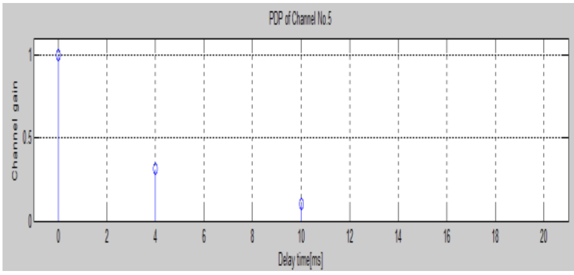

Fig.3: Delay Profile

Figure4 gives the information about the channel power of SUI5 channel. SUI5 channel has 3 taps. The following output determines the power in each tap of channel. This output is obtained by considering fading time.

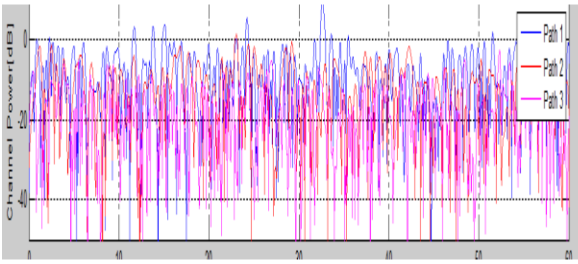

Fig.4: Channel Power

Figure 5 is the power spectral density of SUI5 channel. It shows PSD of SUI5 channel in each tap. Here by considering fadtime with welsch spectrum is indicated in blue line and PSD of SUI5 channel in red line.

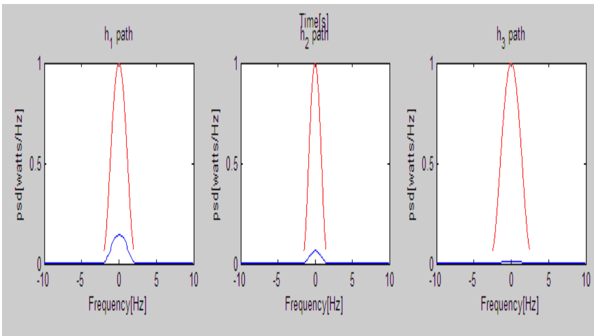

Fig.5: Power Spectral Density

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Pulse Amplitude Modulation(BER Vs SNR)

Figure 6 bit error rate analysis of SUI5 channel with PAM modulation technique. In PAM modulation the data is transmitted by varying the amplitude of the pulses in the regular timed sequence. Signal to noise ratio of this channel is 12 dB using PAM modulation.

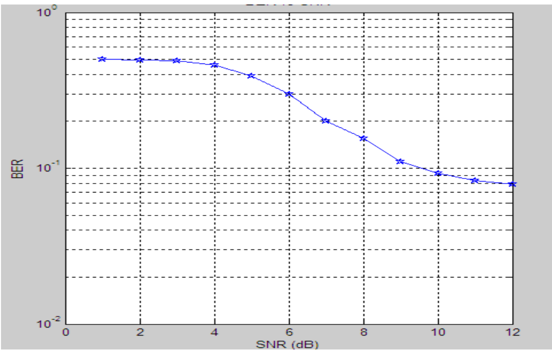

Fig.6: Pulse Amplitude Modulation

BPSK Modulation (BER Vs SNR)

Figure 7is the bit error rate analysis of SUI5 channel with BPSK modulation technique. Signal to noise ratio of this channel is 25 dB using BPSK modulation.

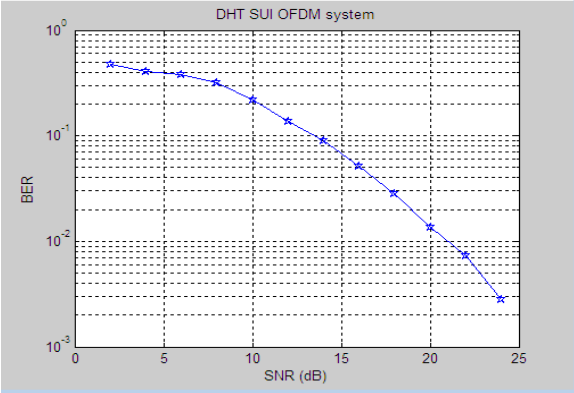

Fig.7: BPSK Modulation

Here the PAPR analysis is done using PTS technique with different modulation schemes. PAPR analysis of OFDM system using BPSK modulation is shown in the following figure 8. PAPR can be calculated in terms of complementary cumulative distribution function. It is observed that the PAPR for BPSK modulation is 4.8dB.

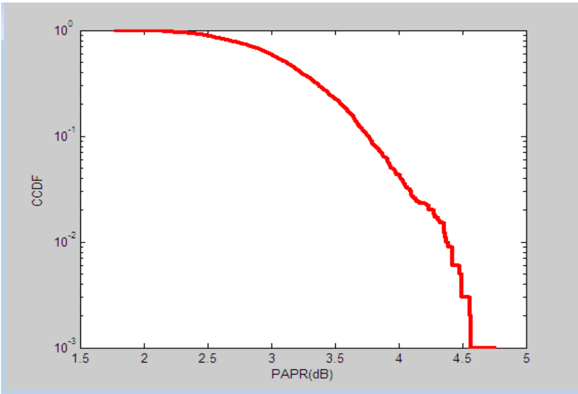

Fig.8: PAPR Analysis with BPSK modulation

PAPR analysis of OFDM system using PAM modulation is shown in the following figure 9.By using PAM modulation the PAPR has been increased about 8.2dB.By comparing the results PAPR analysis using BPSK modulation is less

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compared to the PAM modulation with SUI5 channel. SO BPSK modulation has better PAPR reduction with SUI5 channel.

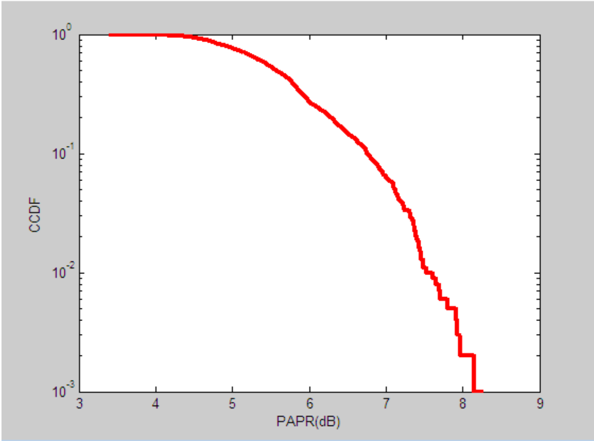

Table1 :Comparison of SUI5 channel and AWGN channel with different modulation techniques

parameters	SUI5 channel		AWGN channel
	BPSK	**PAM**	**QAM**
SNR	24	12	-
BER	0.0020	0.0813	-
PAPR	4.8	8.2	5.1

VI. CONCLUSION

SUI 5 channel can be used in hilly region where the signal distortion is very high. By considering the predefined values for this particular channel the bit error rate as well as PAPR has been calculated. The observation results gives this channel has better performance than the regularly used AWGN channel. Here the BER analysis using BPSK modulation has better performance compared to PAM modulation.
Fig.9: PAPR Analysis with PAM modulation

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