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DFT-Spread Combined with PTS and SLM Method to Reduce the PAPR in VLC-OFDM System

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***Abstract—Wireless* communication system is an important technology in communication system by using LED lights. Visible Light Communication OFDM system is a new way of data communications medium using visible light. Visible light frequency spectrum bandwidth ranges from 400 THz to 800 THz. This spectrum of visible light is larger than the radio frequency system. In visible light communication system due to LED device it is possible to transmit the different types of signal at a time, for this multiple signal transmission orthogonal frequency division multiplexing (OFDM) system was introduced in VLC. OFDM modulation provides the high data rate transmission of signal due to its multicarrier phenomena in a long range of communication. Due to its orthogonal multicarrier phenomena it can be reduces the inter symbol interference (ISI) in communication system, but only one drawback of this OFDM system is peak to average power ratio (PAPR). Peak to average power ratio can affecting the performance of communication system. Presence of PAPR in system increases the in band distortion of signal also large amount of dc bias appear in transmission of signal. Therefore reduction of this PAPR is an important criteria in VLC communication system, for reduction of this PAPR Selected Mapping, Partial Transmit Sequence, Discrete Fourier transform spread techniques are used in VLC system. In this paper first apply all three techniques individually to VLC for reduced PAPR, after that make a combination of two techniques algorithm and apply to system for PAPR reduction and at the last make a combination of three techniques to further reduced PAPR in VLC system. Shows this simulation result in statistical point of view the Complementary Cumulative Distribution Function (CCDF) is used.**

***Index Terms* — Visible light communication; OFDM system; Peak to average power ratio reduction techniques.**

I. INTRODUCTION

In fourth generation of the mobile communication system visible light communication system is now days used for high speed transmission of data. Visible light frequency spectrum bandwidth ranges from 400 THz to 800 THz. Due to this large bandwidth it is possible to allow more users in the system. Visible light communication transmits the signal by using LED light. This VLC communication is different from the radio frequency communication. The communication range of VLC is limited it ranges from 1 to 80 meters. This is a line of site communication. Also the data rate is lower than the RF communication. Its data rate ranges from kilobits per second to 10 megabits per second. With the rapid growth in light emitting diodes (LEDs) technology it is possible to implement this technology for commercially viable purposes. LEDs have a different advantage and applications. LEDs are now replacing by laser diodes which have less complex circuitry to operate them and no additional thermal and optical stabilization circuits are needed.

II. OFDM SYSTEM

Orthogonal Frequency Division Multiplexing has wide ranges uses in wireless communications system because of its high data rate handling capacity. OFDM modulation provides the high data rate transmission of signal due to its multicarrier phenomena in a long range of communication. Due to its orthogonal multicarrier phenomena it can be reduces the inter symbol interference (ISI) in communication system, but only one drawback of this OFDM system is peak to average power ratio (PAPR). Peak to average power ratio can affecting the performance of communication system. Presence of PAPR in system increases the in band distortion of signal also large amount of dc bias appear in transmission of signal. PAPR is an important factor to measure the communication system performances. Presence of PAPR in VLC system will reduce the system stability.

PAPR is given by:

$$PAPR = \frac{\max_{0<n<N} |x(n)|^2}{P_{average}}$$

CCDF is given by:

CCDF (PAPR(X)) = Pr(PAPR(x)) > PAPR0

III. PAPR REDUCTION TECHNIQUES

Reduction of this PAPR in VLC system, Selected Mapping, Partial Transmit Sequence and Discrete Fourier transform spread techniques are used in VLC system. In this paper first apply all three techniques individually to VLC for reduced PAPR, after that make a combination of two techniques algorithm and apply to system for PAPR reduction and at the last make a combination of three techniques to further reduced PAPR at its lowest value.

A. PARTIAL TRANSMITT SEQUENCE

Partial transmit sequence is a data signal scrambling algorithm technique. J. B. Huber and S. H. Muller was first introduced this techniques in 1997. PTS method is carried out the random signal phase weight to calculate the lowest signal PAPR. It is a distortion less optimization technology. PTS provide better PAPR reduction with good BER.

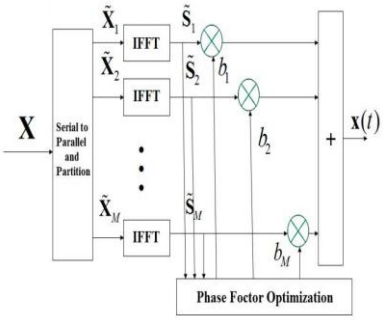

Figure 1.The block diagram of the PTS method in VLC system

PTS method used in VLC OFDM system block diagram is shown in figure1.In this PTS method the input data symbols in X are partitioned in to sub blocks. This sub blocks $X^{(i)}$ are transformed in to M time-domain partial transmit sequences. These sequences of signal are independently rotated with phase factors (bi), These signals are then combined to further produce the time domain OFDM signal packet back. PTS algorithm selects a vector (bi) such a way that the PAPR of the corresponding transmit input sequence will be the lowest value. For reducing the OFDM signal PAPR value in VLC system, the Partial Transmit Sequence method is combined with Discrete Fourier transform spread are used. The PTS method used individual in VLC OFDM system reduced PAPR approximately by 2.2 dB.

B. SELECTED MAPPING

SLM is the most popular PAPR reduction method in VLC. By choosing efficient phase rotation factors the PAPR performance of SLM-OFDM is improved. This will reduce the information data rate and increase the size of side information.

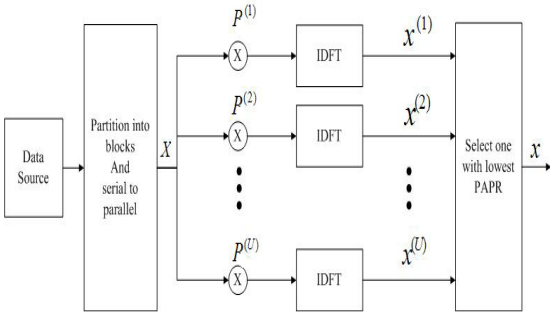

Figure 2.The block diagram of the SLM method in VLC system

The above figure 2 shows the SLM algorithm technique used in VLC communication system. The data input signal is firstly partition into the sub blocks X after that this parallel data sequence are multiplied with the independent phase rotation sequence. After performing this operation the frequency domain signal is converted into the time domain with the help of IDFT operation. And at the last all sequences are combine and select the one signal which having lowest PAPR value. SLM method used individually in VLC OFDM system reduced PAPR approximately by 3.7 dB.

C. DFT-SPREAD

Discrete Fourier transform spread algorithm is also used to reduce OFDM signal PAPR in VLC system.

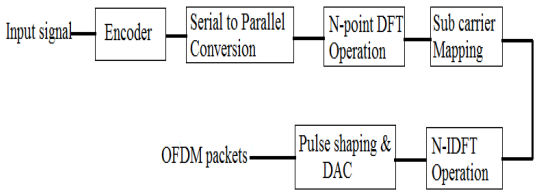

Figure 3.The block diagram of the DFT method in VLC system.

The above figure 3 shows the DFT algorithm applied to VLC system for reduction of PAPR. In this technique input data is firstly encoded and transform into parallel. This signal is converted into frequency domain by using DFT. After that

OFDMA modulation is carried out and then signal is converted into the time domain. This technique used pulse shaping filter With DAC to pass signal which having low value of PAPR. This technique is not effective to use alone, PAPR reduction performance is not good as compare to other techniques. So this technique used combined with other two techniques. DFT-S method used in VLC OFDM system reduced PAPR approximately by 1.33 dB. Therefore DFTS method combine with PTS and SLM method for PAPR reduction in Indoor VLC system was used. Also PTS method combine with SLM for PAPR reduction in Indoor VLC system was used. And at the last applied DFT-PTS-SLM Method combine for PAPR reduction in Indoor VLC system was used.

IV. SIMULATION ANALYSIS

The following simulation CCDF plot through MATLAB verify the performance analysis of PTS, SLM and DFTS methods used individually for PAPR reduction under visible light communication in OFDM system. Also shows the DFT+PTS, DFT+SLM, PTS+SLM and DFT+PTS+SLM combination algorithm simulation results.

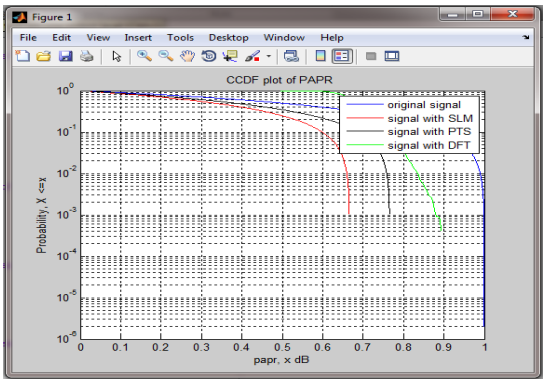

Figure 4.Simulation of PAPR performance analysis of the DFT, PTS and SLM algorithms

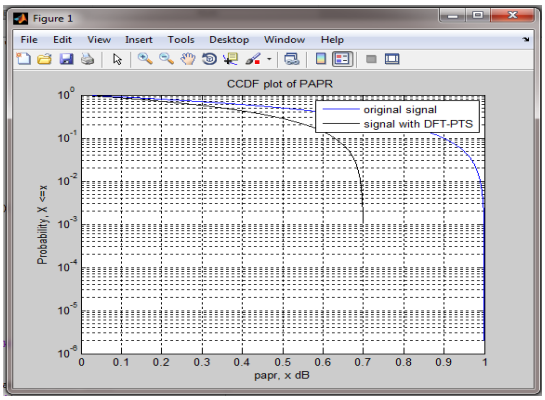

Figure 5.Simulation of PAPR performance analysis of the DFT+PTS algorithm

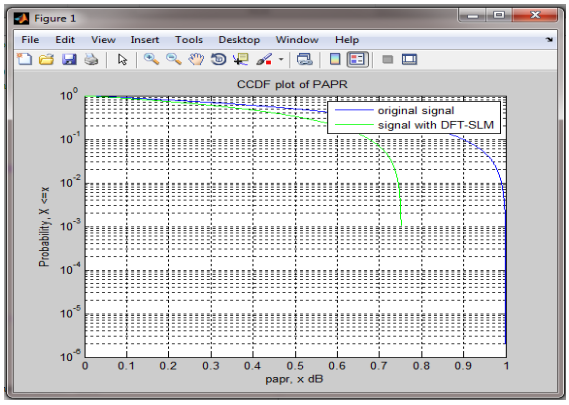

Figure 6.Simulation of PAPR analysis of the DFT+SLM algorithm

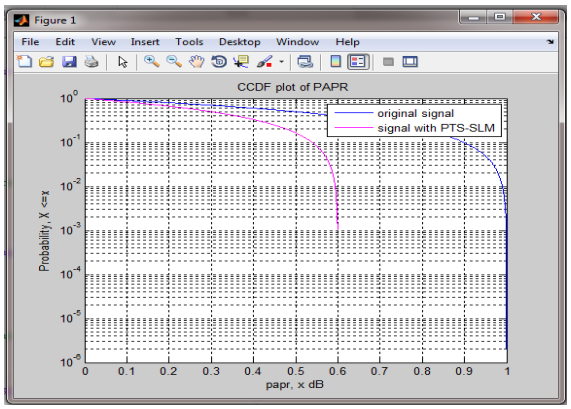

Figure 7.Simulation of PAPR analysis of the PTS+SLM algorithm

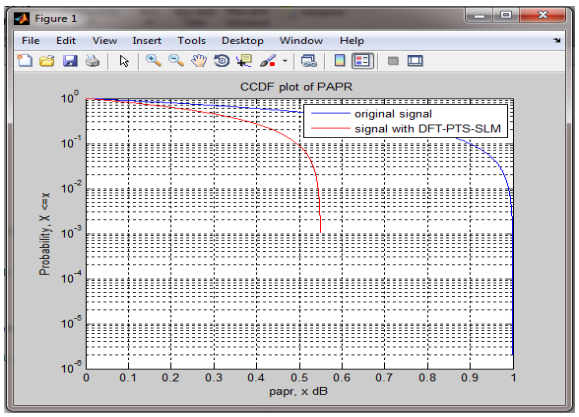

Figure 8.Simulation of PAPR analysis of the DFT+PTS+SLM algorithm

The above figures show the CCDF plot for the performance of different PAPR reduction techniques. In figure 4 shows the simulation performance of the individual used of DFT, PTS and SLM algorithm. Here we can see that SLM has better PAPR reduction performance than other two techniques. In figure 5, 6 and 7 shows the hybrid result simulation of two techniques out of this

Combination PTS+SLM is better PAPR reduction performance than the other combination. And at the last figure 8 shows the PAPR reduction performance by combining all three techniques which gives better result than the others.

V. RESULT

The following figure shows the comparison table of PAPR values of DFT, PTS, SLM and their hybrid combination.

PAPR reduction techniques	Original signal PAPR in VLC system	Reduced PAPR in VLC system
SLM	13.2382	9.5362
PTS	13.2382	10.9722
DFT	13.2382	11.9070
DFT+PTS	13.2382	10.9716
DFT+SLM	13.2382	10.9850
PTS+SLM	13.2382	8.9928
DFT+PTS+SLM	13.2382	7.8020

Figure 9.Comparison of different PAPR reduction techniques

VI. CONLUSION

It is observe that combination of DFT-PTS, DFT-SLM and PTS-SLM methods reduced better PAPR in VLC OFDM system instead of using individual PTS, SLM and DFT methods. Also by applying DFT-PTS-SLM, all three combined techniques to VLC OFDM system, results this combination of techniques reduced better PAPR than the combination of two techniques.

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