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Review Paper on Reduction Techniques of PAPR in VLC OFDM System

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Abstract— Communication is one of the important aspects of everyday life. With the advancement in age and its growing demands, there has been rapid growth in the communications field. Visible Light Communication OFDM system is a data communications medium using visible light. Visible light frequency spectrum bandwidth ranges from 430 THz to 790 THz. Visible light communication technology enabling data transmission by using light emitting diode (LED). This device has attracted much attention in recent communication system. Orthogonal Frequency Division Multiplexing (OFDM) has been widely used in wireless communications technology due to its high data rate, frequency selective fading and immunity to delay spread and other advantages, but besides these benefits the main disadvantages is the high peak to average power ratio (PAPR). This peak to average power ratio is an important feature to analyze the system performances. PAPR will increase the system complexity and reduce the communication system performance. High PAPR limit the application of OFDM system. To reduce the OFDM signal peak to average power ratio (PAPR) in VLC system, the Clipping, Selected Mapping (SLM), Partial Transmit Sequence (PTS) and Discrete Fourier transform spread (DFT-S) techniques are used. For statistical analysis of PAPR the Complementary Cumulative Distribution Function (CCDF) is used. Performance analysis in terms of CCDF and BER plots will be shown. In this paper, PAPR problem in VLC is defined and this paper present different PAPR reduction techniques analysis.

Keywords— Visible Light Communication; Orthogonal Frequency Division Multiplexing; PAPR reduction techniques

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is one of the Strong candidates for Transmission of high data rate due to Multicarrier Modulation, which provides high spectral efficiency, low implementation, low complexity and non linear distortion. Due to these advantages of the OFDM system, always used in various communication systems. But the major problem arrives while implementing this system is the high peak to average power ratio of this system. A high value of PAPR in system increases the complexity of the ADC and DAC converter and reduces the spectral efficiency of the radio frequency (RF) power amplifier.

II. SYSTEM STRUCTURE

Visible Light Communication uses the visible light spectrum bandwidth which ranges from 430 THz to 790 THz. This bandwidth is larger than the radio frequency (RF) bandwidth, which ranges from 3 kHz to 300 GHz. With a larger bandwidth it is possible to accommodate more users and potentially achieve highest data transfer rates because each user can be given a larger portion of the bandwidth to transfer information. VLC addresses the issue of energy efficiency and requirement of wireless system capacity.

VLC technology enabling data transmission by modulating light emitting diode devices has attracted much attention recently. Typical transmitters used for VLC are visible light LEDs and receivers are photodiodes and image sensors. 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 of being highly efficient at very low cost applications which enables them to be widely implement in various applications such as indoor and outdoor lighting, 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. White LED offers advantageous such as high brightness, reliability, and lower power consumption, maintenance-free and long lifetime. In visible light communication using LED lights, the large received power, which consists of the optical paths signal delay propagation, causes inter symbol interference. Visible light communication has properties that are having both advantageous and disadvantageous as compared to radio wave wireless communication. The main disadvantages of VLC are communication distance and data rate.

The data communication range of visible light communication is typically between 1 to 90 meters. This distance is too short as compared to radio-wave communication, due to the fact that visible light communication is line-of-sight communication, which means that data communication is interrupted when there is an object present between a transmitter and a receiver. There is one more disadvantage of visible light communication, which is data rate. Its data rate is between kilobits per second to 10 megabits per second.

III. STRACTURE REPRESENTATION

Orthogonal Frequency Division Multiplexing has wide ranges uses in wireless communications system because of its high data rate handling capacity. One of the main disadvantages of OFDM is the high PAPR. PAPR is an important criterion to measure the communication system performances. Presence of PAPR in VLC system will increase the system complexity and reduced performance. In VLC systems, intensity modulation is used at the transmitter. The forward signal drives the LEDs which in turn converts the magnitude of the electric signal into optical intensity. The human eye cannot see the fast-changing variations of the light intensity, and only responding to the average light intensity. A photodiode (PD) convert the received incoming optical power into the amplitude of an outgoing electrical signal. High PAPR value for the fixed number of data bits per sample introduces the serious quantization error. To minimize this quantization error, the accuracy should be increased. As a result the complexity of ADC and DAC will increase. To overcome this problem, linear amplifiers are needed
PAPR is given by:

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

The complementary cumulative distribution function of the PAPR of OFDM signals is used to evaluate the PAPR reduction performance accurately from the statistical analysis. CCDF plot helps us to measure the probability that the PAPR of a certain data block exceeds the given threshold value which is given as:

$$CCDF\ (PAPR(x(n))) = Pr(PAPR(x(n)) > PAPR0$$

IV. PAPR REDUCTION TECHNIQUES

To reduce OFDM signal PAPR in VLC system, Clipping, Frequency Symbol Spreading and Priority Power selection, Partial Transmit Sequence (PTS), Discrete Fourier transform spread (DFTS), and selected mapping (SLM) techniques are used.

A. Clipping

Clipping is the simplest method to reduce the signal PAPR of the OFDM system. The PAPR of OFDM signal decreases after clipping. Clipping method is efficient in terms of PAPR reduction but BER performance is poor. The clipping technique is followed by filtering method to reduce out of band power of OFDM signal. Discrete Fourier transform (DFT) can transform the clipped signal amplitude into frequency domain of OFDM signal. When in band OFDM frequency domain signals are passed to the second inverse DFT (IDFT) then OFDM out-of band signal components are null. Therefore there is no interference occur between the two bands of OFDM signals. Therefore clipping method is reduced PAPR by decreasing the amplitude of signal using filtering operation. As results, not only improve the power amplifier efficiency, but also increase the mean transmit power. This method is only applicable for radio frequency communication so to reduce PAPR in VLC OFDM system we move towards other techniques.

B. Frequency Symbol Spreading and Priority Power selection

To improve the BER performance of OFDM signals, the Frequency Symbol Spreading (FSS) and Priority Power selection (PPS) has been used visible light communications. The subcarrier data spread in all subcarriers by a different spreading code in FSS. As a result the system performance can be improved because the effect of channel distortion spread in all subcarriers. After using FSS, PPS can exploits the diversity of each signal power and allocates the data which has a large signal power on the subcarrier which has good channel response. Therefore this method makes the improvement of the BER and PAPR characteristics.

C. Partial Transmit Sequence

The PTS method is a typical algorithm of signal scrambling techniques. It was first introduced by S. H. Muller and J. B. Huber in 1997.The PTS method is adopted to carry out random phase weighting to the signal to reduce the OFDM signal peak value probability signal appears, thereby reducing the PAPR of OFDM signal. The PTS is effective distortion less PAPR reduction techniques. It provides PAPR reduction and good BER performance in VLC as compared with clipping and filtering. PTS method used in VLC OFDM system reduced PAPR approximately by 2.2 dB. However PTS is computationally complex and need to transmit appropriate side information. In PTS, many researchers are trying to reduce computational complexity in different ways because selection of optimized phase vector is tedious process. For reducing the OFDM signal PAPR value in VLC system, the Partial Transmit Sequence method is combined with Discrete Fourier transform spread are used.

D. 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. SLM-OFDM system used with limited size of side information, the number of selected phase rotation factors is also being limited. SLM method used in VLC OFDM system reduced PAPR approximately by 3.7 dB. The PAPR performance was increase with more rotated groups present in SLM, but more data bits of side information are required also the data rate is lower.The OFDM signal with the lowest PAPR is selected for light transmission in the SLM method. Unlike the conventional PTS, SLM is not required to transmit and recover the side information about the phase rotation. SLM technique avoids the side information requirement at the receiver by cyclic shifting the pilot subcarriers for each of the independent mappings in pilot assisted SLM-OFDM systems. The effectiveness of the method is presented in presence of SSPA for marine channel.

E. DFT-Spread

DFT-S OFDM has been proven one of the most effective ways to reduce OFDM signal PAPR. On the basis of subcarrier allocation patterns, DFT-S OFDM system can be divided into interleaved DFT-Spread (IDFT-S) OFDM and localized DFT-Spread (LDFT-S) OFDM. In Visible Light Communication systems, the requirement of real signals, special circular conjugate symmetry

constraints are imposed on to the OFDM subcarriers. It makes the DFT-Spread OFDM implementation in VLC quite different from the conventional DFT-Spread OFDM structure.
With this DFTS technique, the theoretical analysis is firstly carried out to help characterize the OFDM system PAPR reduction value in VLC systems. DFT-S method used in VLC OFDM system reduced PAPR approximately by 1.33 dB. On the basis of this result detail comparisons of DFT-Spread OFDM with other techniques in terms of OFDM PAPR reduction are made for VLC systems. Simulation results analysis shows that the DFTS system reduced PAPR in OFDM system and also achieves a high performance gain in BER without any losses in the system transmission rate.

V. CONCLUSION

In this paper, with the help of comparative review of all the PAPR reduction techniques, Clipping, Frequency Symbol Spreading (FSS) and Priority Power selection (PPS), Partial Transmit Sequence (PTS), Selected Mapping (SLM) and Discrete Fourier transform spread (DFTS) have been analyzed. It is observe that SLM reduced PAPR approximately by 3.7dB which is better than the PTS and DFT method which reduces PAPR approximately by 2.2dB and 1.33dB respectively

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