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AN OFDMA UPLINK SYSTEM APPROACH FOR PAPR REDUCTION IN MOBILE WI-MAX USING RANDOM INTERLEAVED OFDMA

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ABSTRACT

In all-optical OFDM systems, high PAPR is a serious intrinsic defect, deteriorating nonlinear impairment in optical fibers. This paper probes the peak-to-average power ratio (PAPR) theory in all-optical orthogonal frequency division multiplexing (OFDM) optical fibre communication systems. To increase dramatically future wireless communications, many wireless standards (WiMax, IEEE802.11a, LTE, DVB) have adopted the OFDM technology. On the other hand, WiMAX is one of the hottest broadband wireless technology today. WiMAX systems are expected to deliver broadband access services to enterprise and residential customers in an economical way. But, due to outside interference these (WiMAX and OFDM channels) experience the negative effect of a higher value of peak to average power ratio (PAPR or we also call it crest factor). High PAPR (Peak to Average Power Ratio) is the main drawback of OFDM systems. The major aim of this research focuses the mobile WiMAX and typical PAPR reduction techniques available in the literature. We also introduce two precoding based systems: ZCMT precoded random-interleaved OFDMA uplink system and SLM based ZCMT precoded random-interleaved OFDMA uplink system. Computer simulation shows that the PAPR of the both proposed systems have less PAPR than the WHT precoded random-interleaved OFDMA uplink systems and conventional random-interleaved OFDMA uplink systems. These systems are efficient, signal independent, distortion less and do not require any complex optimizations. Thus, it is concluded that the both proposed uplink systems are more favorable than the WHT precoded random-interleaved OFDMA uplink systems and conventional random-interleaved OFDMA uplink systems for the mobile WiMAX systems. The results are concluded with respect to desired Conventional RI-OFDMA system,

WHT Precoded RI-OFDMA system, DST Precoded RI-OFDMA system of PAPR values 13, 12 and 9 at 512/QAM.

Keywords - Peak to average power ratio (PAPR); random interleaved orthogonal frequency division multiple access (RI-OFDMA); Worldwide interoperability for microwave access (WiMAX);Walsh- Hadamard Transform (WHT).

INTRODUCTION

IEEE.802.16 standard defines numerous wireless metropolitan area network (WMAN) technologies. WiMAX is a certification applied to 802.16 by- product tested by the WiMAX forum. IEEE 802.16d stands for fixed WiMAX and IEEE 802.16e stands for mobile WiMAX.[1] WiMAX allows for an adequate use of bandwidth in a wide frequency range, and can be used as a last mile key solution for broadband internet access.[2] OFDM has been steadfast as a part of IEEE 802.11a and IEEE802.11g for high bit rate data transmission over wireless LANs.[3] Orthogonal frequency division multiple access(OFDMA) is a multiple access version of the orthogonal frequency division multiplexing (OFDM) systems.[4]The mobile WiMAX air interfacetapss orthogonal frequency division multiple access (OFDMA) a multiple access technique for its transmission uplink (UL) and downlink (DL) to enhance the multipath performance. OFDMA system splits the high speed data stream into variance of parallel low data rate streams.[5]

One of the major limitation of OFDM signals is the high peak to average power ratio (PAPR) of the transmitted signal.High PAPR implies that a highly linear power amplifier is required at the transmitter.The high peaks of an OFDM signal arises when the subsymbols for each subcarrier are combined up coherently. So OFDM signals can cause serious problems including a severe power loss at the transmitter which is particularly not affordable in portable wireless systems.[6],[7]Generally, the radio system uses HPA in the transmitter side to obtain maximum output power efficiency. The operating area of HPA is normally at or near the saturation region. Also the nonlinear characteristics of the HPA are very tender to the difference of the signal amplitudes. This difference in the OFDM amplitudes is very large with high PAPR. So, the high PAPR on the HPA will introduce intermodulation between different sub-carriers and interference into the systems. This interference decreases the BER performance. Also, this high PAPR forces the amplifier for having huge back off power for linear amplification of the signal. This type of linear working amplifier has poor power efficiency [8-11]. This is the major impact of PAPR in OFDMA systems.

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PAPR reduction is a well-known signal processing issue in multi-carrier transmission and large number of techniques have been propounded in the literature during the past decades. These techniques include amplitude clipping and filtering, coding , tone injection (TI) and tone reservation (TR) , nonlinear companding transforms Active Constellation Extension , and multiple signal representation methods, such as selected mapping (SLM), partial transmit sequence (PTS), Precoding based Selected Mapping (PSLM) and interleaving . The existing approaches differ in terms of requirements and restrictions they impose on the system.[12-13]There are two individual approaches for subcarrier mapping in OFDMA systems, namely distributed subcarrier mapping and localized subcarrier mapping. The distributed subcarrier mapping can be further categorised in two modes, random interleaved mode and interleaved mode .The random interleaved subcarrier mapping is favourable for mobile WiMAX because it boosts the capacity in frequency selective fading channels and offers maximum frequency diversity.[4]

In this paper two precoding based systems: ZCMT precoded random-interleaved OFDMA uplink system and SLM based ZCMT precoded random-interleaved OFDMA uplink system are introduced and CCDF based comparison of PAPR of the ZCMT, DHT and WHT precoding techniques in interleaved OFDMA uplink system 512-QAM is taken.

I. PROBLEM FORMULATION

WIMAX takes OFDM in consideration to be its physical layer to satisfy and guarantee the very big data rates (speed) in frequency selective environment. High PAPR is the main disadvantage for OFDM. Due to this high PAPR, the chances of operating point for the linear power amplifier being shifted towards the high saturation region at any given time instant becomes more and more probable. In-band distortion and out-of-band radiation are some side effects for this shifting of operating point. This issue can be easily avoided by changing the dynamic range of power amplifier and increasing it. But yes, it can surely pave way for larger size and higher production cost of power amplifier. Hence, if we take into consideration the power constraint problem, it is very much required and necessary to reduce the PAPR.

II. OBJECTIVES

Following are the main objectives we have to deal with

1. Reduce PAPR
2. Improve efficiency in terms of MSE and PSNR

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3. Reduce the magnitude variation
4. Achieve smaller back off margin
5. Higher PAPR reduction gains

III. METHODOLOGY

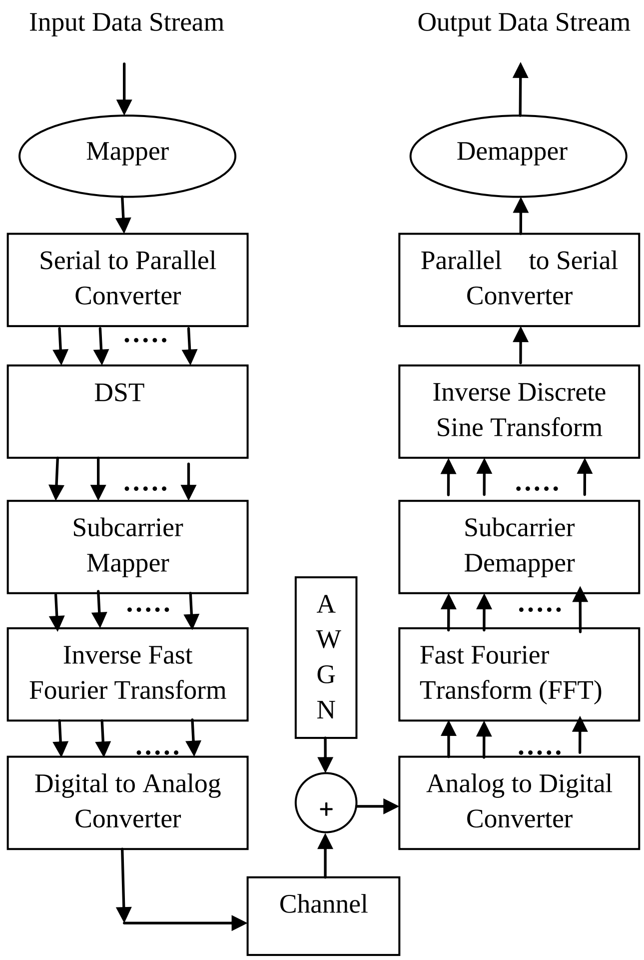

Fig.4.1 DST precoding based random interleaved OFDMA

The steps which are taken throughout the process to achieve the desired objectives and the whole scenario is be divided into 2 parts as shown in fig 4.1.

1. Transmitter
2. Receiver

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IV. SIMULATION RESULTS

Extensive simulations in MATLAB(R) have been carried out to evaluate the performance of the proposed SLM based ZCMT precoded random-interleaved OFDMA uplink system with pulse shaping.

Table 5.1 characterstics of FFT Inputs

Channel Bandwidth	5MHz
Precoding	ZCMT,DHT,WHT
Modulation	QPSK, QAM
Pulse Shaping	CCDF
Subcarrier Mapping Mode	Random Interleaved
CCDF Clip Rate	10^{-3}

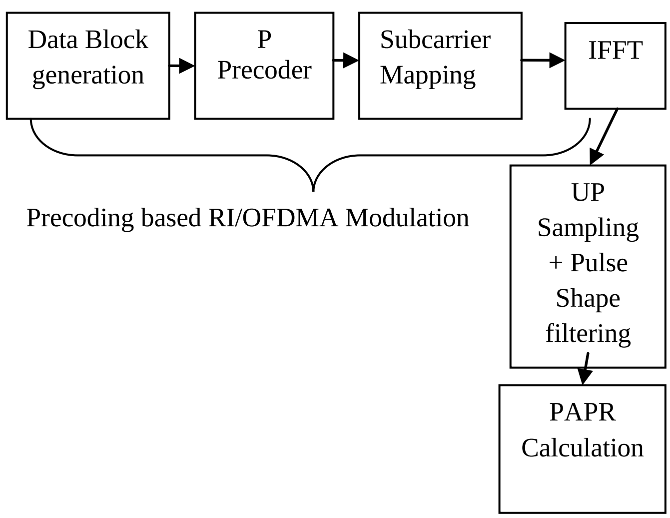

Fig 5.1 Block diagram of PAPR calculation for ZCMT/OFDMA uplink System

To show PAPR analysis of the proposed system, the data is generated randomly then modulated by QPSK, 512 -QAM respectively. We evaluate the PAPR statistically by using complementary cumulative distribution function (CCDF). The CCDF of the PAPR for ZCMT precoded random interleaved OFDMA uplink signal is used to express the probability of exceeding a given threshold PAPR0 (CCDF = Prob (PAPR > PAPR0)). We compared the simulation results of proposed system with WHT precoded random interleaved OFDMA uplink systems and conventional random interleaved OFDMA uplink systems. To show the PAPR analysis of proposed system with pulse shaping in MATLAB® we considered RRC rolloff factor α = 0.22 and scaling factor 0.5.

The results concluded that PAPR reduction techniques are obtained at varying sizes using CMA convergence. Initially the OFDMA size is maintained 1024.Different algorithms are used with respect to iterations.

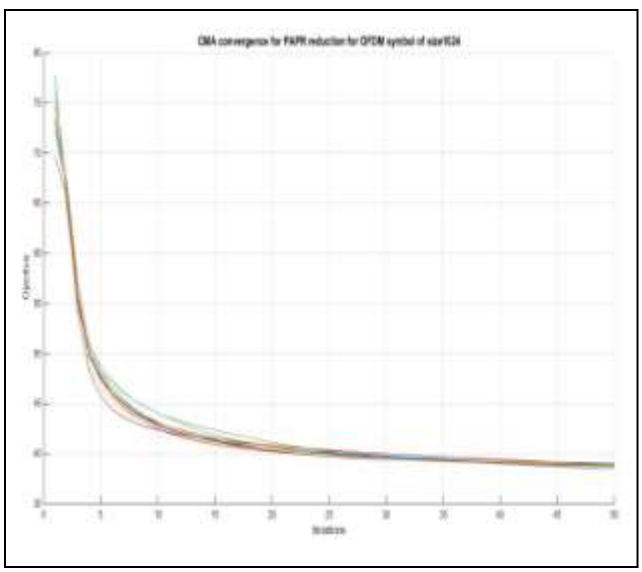

Fig 5.2 CMA Convergence for PAPR reduction for OFDM symbol of size 1024.

For convergence, the algorithm is initialized with first iteration. The algorithm should run until the cost function converges. In practice convergence is fast and the algorithm is run for a fixed small number of iterations. To satisfy the power constraint, we can simply scale the result after convergence. A difference with the standard CMA is that, here, and a good solution does not necessarily exist. The usual application of CMA is for a linear combination of constant modulus

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sources for which, without noise, a perfect beam former exists. The present situation could be said to correspond to a very noisy source separation situation. The graph shows that iterations values with respect to objective whenever the FFT size is 1024.

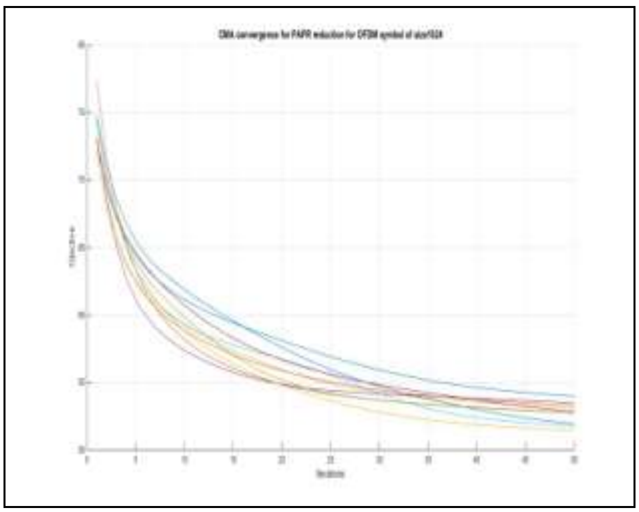

Fig 5.3 CMA Convergence for PAPR reduction for OFDM symbol of size 1024 with unit optimization method

Using desired unit circle optimization method iterations are shown like this.

Similarly, In this simulation When Mt=2 transmit antenna. The simulation shows that the proposed techniques attain a PAPR reduction of up to 5.5 dB of precoded 50RBs and 9.6 of original PAPR at FFT size 1024 as shown in below diagram.

When a 512-QAM modulator and an OFDM modulator are created, the QAM modulated signal will be evaluated by itself and evaluated again after OFDM modulation applied.

hMod=comm.RectangularQAMmodulator('ModulationOrder',512);
hOFDM=comm.OFDMmodulator('FFTLength',1024,
'CyclicPrefixLength',32);

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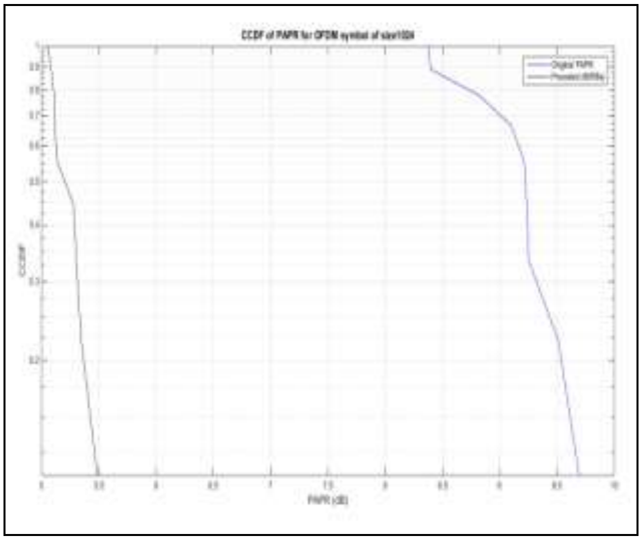

Fig 5.4 CCDF of PAPR reduction for OFDM symbol of size 1024

Similarly, In this simulation When Mt=2 transmit antenna. The simulation shows that the proposed techniques attain a PAPR reduction of up to 5.2 dB of precoded 30RBs and 10.1 of original PAPR at FFT size 512 as shown in below diagram.

When a 512-QAM modulator and an OFDM modulator are created, the QAM modulated signal will be evaluated by itself and evaluated again after OFDM modulation applied.

hMod=comm.RectangularQAMmodulator('ModulationOrder',512);
hOFDM=comm.OFDMmodulator('FFTLength',512, 'CyclicPrefixLength',32);

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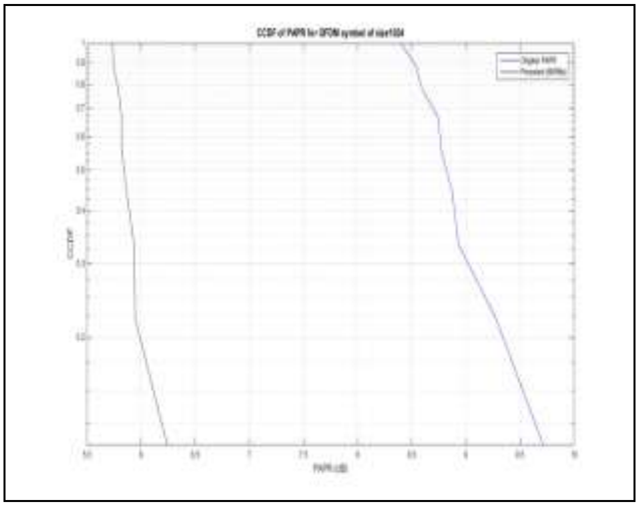

Fig 5.5 CCDF of PAPR reduction for OFDM symbol of size 1024 with unit optimisation

This graphs has a scaling factor of 1 with FF size as 1024. The optimization method used here is Unit Circle.

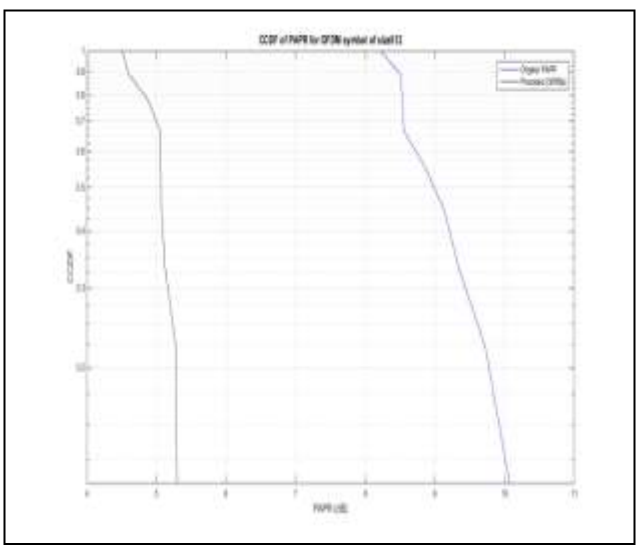

Fig 5.6 CCDF of PAPR reduction for OFDM symbol of size 512

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Here when optimization method is block CMA then scale factor obtained is 0.5 whenever FFT size reduced to 512. Meanwhile, according to the simulation model When Mt=2 transmit antenna. The simulation shows that the proposed techniques attain a PAPR reduction of up to 5.2 dB of precoded 15RBs and 9.1 of original PAPR at FFT size 512 as shown in below diagram.

When a 512-QAM modulator and an OFDM modulator are created, the QAM modulated signal will be evaluated by itself and evaluated again after OFDM modulation applied.

hMod=comm.RectangularQAMmodulator('ModulationOrder',512);

hOFDM= comm.OFDMmodulator('FFTLength',256, 'CyclicPrefixLength',32);

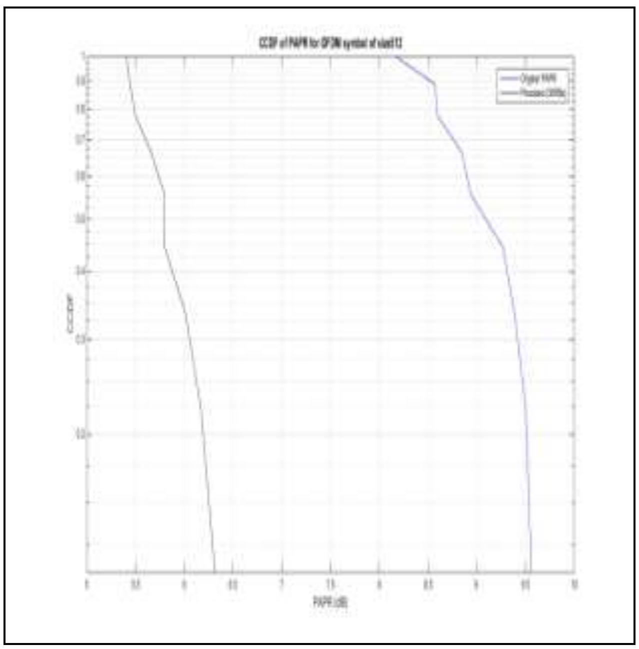

Fig 5.7 CCDF of PAPR reduction for OFDM symbol of size 1024 using unit optimation

This graphs has a scaling factor of 0.5 with FF size as 512. The optimization method used here is Unit Circle.

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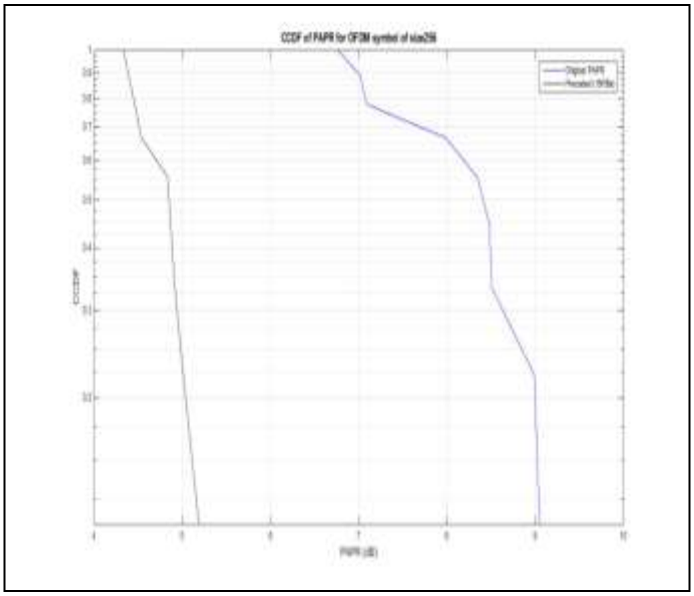

Fig 5.8 CCDF of PAPR reduction for OFDM symbol of size 256

Here when optimization method is block CMA then scale factor obtained is 0.5 whenever FFT size reduced to 512.

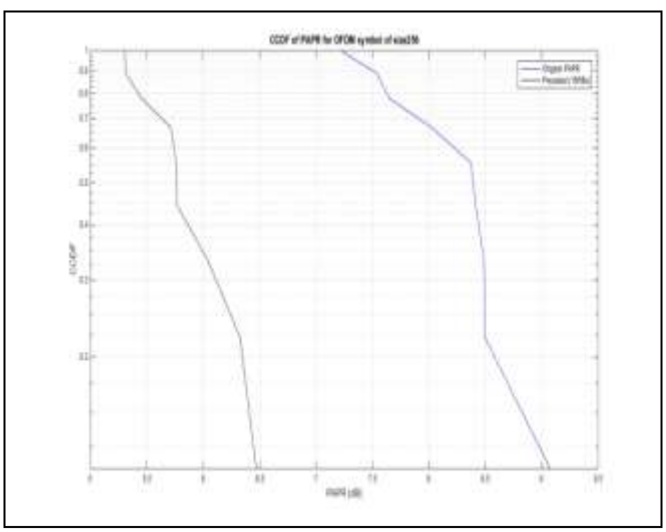

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Fig 5.9 CCDF of PAPR reduction for OFDM symbol of size 256 with unit optimization

This graphs has a scaling factor of 0.25 with FF size as 256. The optimization method used here is Unit Circle.

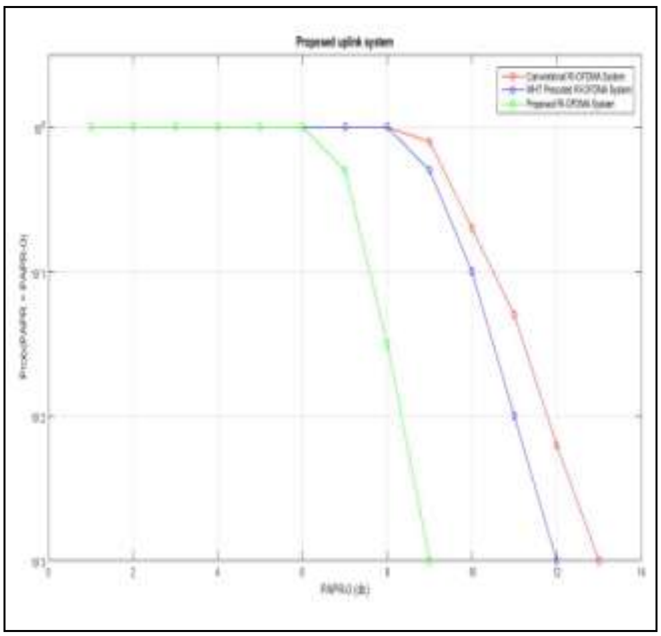

Fig 5.10 CCDF based comparison of PAPR of the ZCMT, DHT and WHT precoding techniques in interleaved OFDMA uplink system using 512-QAM.

Figure 5.10 illustrates the CCDF comparison of PAPR of the DST precoding based RI-OFDMA uplink system with the WHT precoding and the conventional RI-OFDMA uplink system without precoding respectively. The horizontal and vertical axes represent the threshold for the PAPR and the probability that the PAPR of a data block exceeds the threshold, respectively. It can be seen that, at CCDF = 10-3, the PAPR is 13.0, 12 and 9 dB, for conventional RI-OFDMA uplink system without precoding, WHT precoded interleaved OFDMA uplink system and the DST precoded RI-OFDMA uplink system respectively. It is obvious that the proposed DST precoding based uplink system provides considerable PAPR gain when compared to conventional RI-

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OFDMA uplink system without precoding, WHT precoded interleaved OFDMA uplink system and DHT precoded interleaved OFDMA uplink system using 512-QAM modulation.

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