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# ANALYSIS OF PAPR IN IFDMA SYSTEMS USING NORM TECHNIQUE

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***Abstract:* Interleaved Frequency Domain multiple access (IFDMA) utilizes single carrier modulation and frequency domain equalization and has similar performance as of orthogonal frequency division multiple access (OFDMA) and has been adopted for the uplink communications in release 8 LTE. But it is sensitive to non-linear effects duo to the high peak-to-average power ratio (PAPR) of the transmitted signal .The reduction in PAPR is required in order to achieve better BER performance and more power efficiency. This paper presents an Reduced maximum complexity Max Norm algorithm [1] for reducing the PAPR in IFDMA signals .This method does not require the transmission of the side information to the receiver, which improves the utilization of bandwidth. The result has been shown using complementary cumulative distribution function (CCDF) plot and also have been compared with PAPR of IFDMA signals without implementing RCMN technique and which shows that the PAPR of IFDMA signals with RCMN technique have lower PAPR compared to IFDMA signals without using RCMN technique.**

***Index terms: -IFDMA, PAPR, RCMN, CCDF.***

## I. INTRODUCTION

The demands for multimedia-oriented wireless data services have introduced much attraction to high speed broadband wireless techniques in recent years 3GPP long term evolution (LTE) has adopted orthogonal frequency division multiple access (OFDMA)[2] for downlink transmission and single carrier frequency division multiple access (SCFDMA) for uplink SCFDMA is regarded as an Fast Fourier Transform (FFT)- pre-coded version of orthogonal frequency-division multiple access (OFDMA), which is aimed for mitigation of the peak-to-average power ratio problems typically encountered by OFDMA on the uplink .But still SCFDMA suffers from PAPR problem cause an increase in Bit error rate performance (BER) and leads to out of band distortion. Also the PAPR problem requires expensive power amplifiers with requirements of large input back-off (IBO) to reduce the non linearity of the power amplifier which in turn increases the cost of the terminal.


Fig1.Transmission of SCFDMA signals

Fig.1 details the generation of transmitted of symbols of SC-FDMA [3].The basic difference between OFDMA and SC-FDMA transmitter is the DFT mapper block. After mapping data bits into modulation symbols, the modulation symbols are grouped into a block of U symbols by transmitter. These symbols are transformed into frequency domain from time domain symbols by a U-point DFT block. The frequency domain samples are mapped to a subset of V subcarriers where typically V is greater than U. The data symbols are obtained from DFT block are mapped to a subset of subcarriers, this process is referred as subcarrier mapping. Similar to OFDM [4] a V-point inverse discrete Fourier Transform (IDFT) is used to generate the time-domain samples of these subcarriers. By performing different types of modulation schemes such as BPSK, QPSK, QAM, etc. the data is transmitted over the channel. The received data is passed through V-point DFT block where the time domain received data is transformed into frequency domain followed by sub-carrier de-mapping and U-point IDFT block. Finally the parallel data is into serial form and decoded.

## II. PAPR OF I-FDMA SIGNALS

In this section we are going to analyze the PAPR of the SCFDMA signal for interleaved subcarrier mode. In the following derivations, we will assume V1=G1.U1, where U1 is number of subcarriers per block. The integer G1 is the maximum number of terminals that can be transmitted simultaneously. The integer Q1 also can be referred as Bandwidth extension factor.

Let $\{y_{u1}$: u1=0,1,........U1-1} are data symbols obtained after modulation. Then {Yk1 : k=0,1,.......,U1-1} are the frequency domain samples after the DFT of {yu1 : u= 0,1,.........U1-1}, $\{Y_1$p1 : *p*= 0,1,...V1-1} are the frequency domain samples after subcarrier mapping, and {y1v: *v1*=0,1,......,V1-1}are the time symbols after the IDFT of $\{Y_{1p1}$ :*p1*=0,1,......V1-1}.

The PAPR is defined for the transmitted signal y(t) as follows.

$$PAPR = \frac{Maximum\ Power\ Of\ y(t)}{Mean\ Power\ Of\ y(t)} \quad \ldots (1)$$

$$PAPR = \frac{\max\limits_{0 \le T \le VT} imum \left| y(t) \right|^2}{\frac{1}{VT} \int_0^{VT} \left| y(t) \right|^2 dt} \quad \ldots (2)$$

## III. RCMN METHOD

In order to decrease the PAPR the Reduced Complexity Maximum Norm (RCMN) algorithm has been proposed. This method decreases the computational complexity and it is not required to transmit the Side information (SI), it is used to recover the data at the receiver. The given data is first mapped onto Binary phase shift modulation (BPSK) then it is applied to IFFT block. Then RCMN algorithm is performed on the time domain signal .The Block diagram of SCFDMA system with RCMN algorithm is shown in the fig 2.

## IV. RCMN ALGORITHM

The RCMN algorithm steps at the transmitter site are detailed as follows:

Step1: Generate the input data y1= (y1, y2, …,yn) and map with the BPSK or QAM constellation and get the modulated data stream Y,

Step2: First calculate FFT and then calculate IFFT for the mapped data stream y=IFFT(Y),

Step3: Find the maximum value from the IFFT output.

||y1||max = max (y1, y2… yi1… yN1) … (3)

||y1||max = yi1

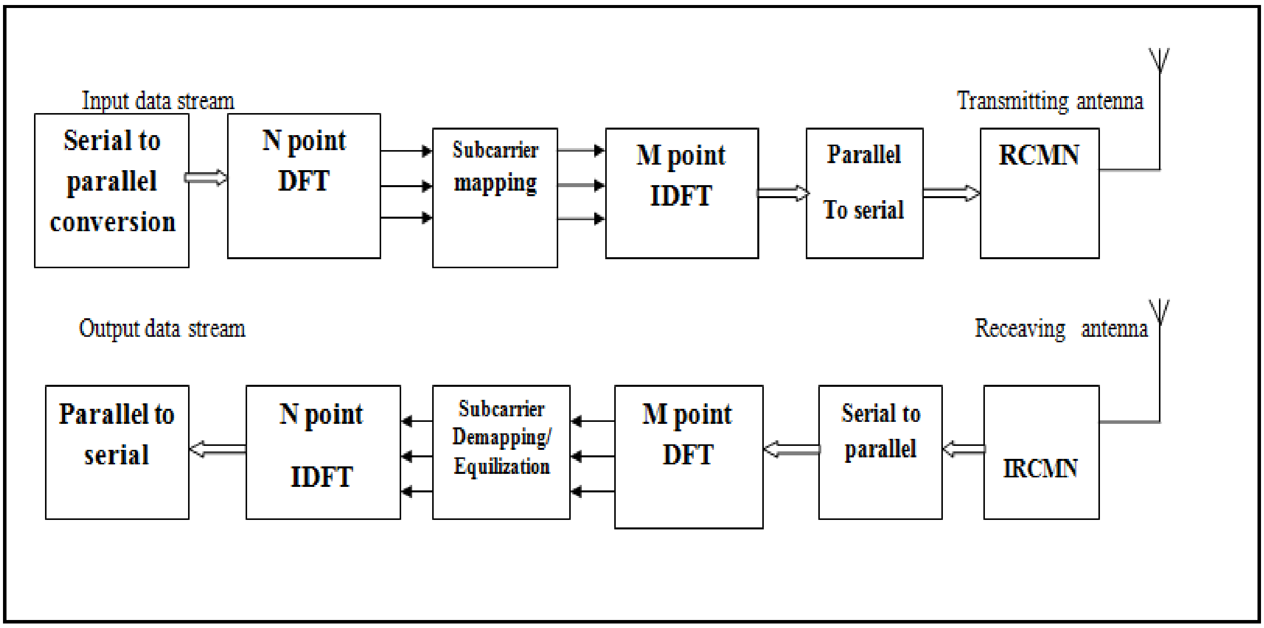


Fig 2 Block diagram of SCFDMA system with RCMN algorithm

Step 4: Defining the parametric form of maximum norm by introducing the parameter β1. Multiply ||y1||max with the value of β1.

*||y1||max = β1*max(y1, y2,…, yi1,…, yN1)

B1*||y1||max = β1*yi1 … (4)

Where, parameter 'β1' adjusts the PAPR of the transformed output. Optimized value of β1 ranges from 2 to 5.

Step5: The output is transformed using RCMN algorithm

z = y – β1*yi

z = ((y1- β*yi), (y2 – β1*yi1),...(yi β1*yi1), …,(yN- β1*yi))

z = ((y1- β1*yi), (y2 – β1*yi),…, (1- β1)*yi,…, (yN- β1*yi)) … (5)

Step6: Transmit the transformed output which offers low PAPR

The RCMN algorithm Transmitter steps are described as a flow diagram in Fig 3.

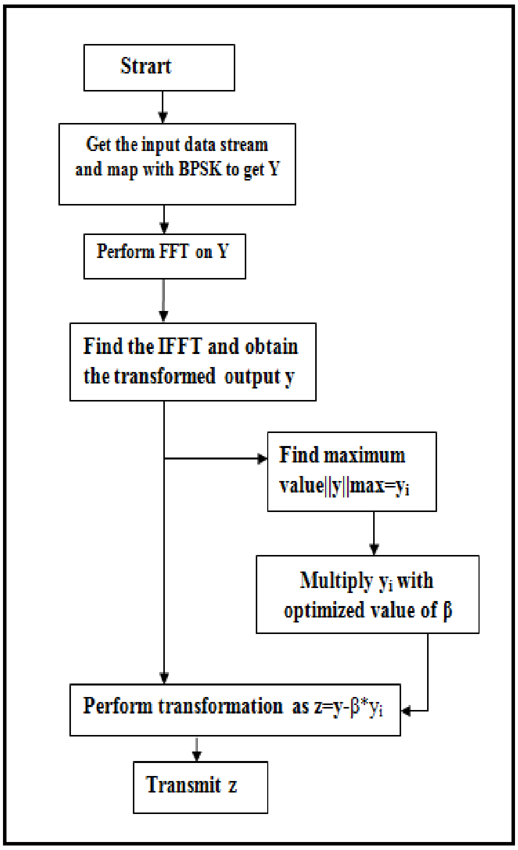


Fig 3. Flow diagram of RCMN algorithm at TRANSMITTER side

The RCMN algorithm steps at the receiver are as follows:

Step 1: Transmitted data block y is received.

Step2: Find the minimum value of z1

min(z1)=min((y1-β1*yi1),(y2–β1*yi1),…(1-β1)*yi1,…,(yN1- β1*yi1))

min(z1) = min((y1- β1 *yi1), (y2 – β1*yi1),…, (1-β1)*yi1,…,(yN1- β1*yi1))

min(z1) = (1- β1)*yi1 … (6)

Step 3: Divide min (y1) by (1- β1) to obtain yi1 , min(y1)/ (1- β1) = yi1

Step 4: To obtain y1, add β1 *yi1 with z1. From equation

Y1 = z1 + β1*yi1

Y1 =((y1-β1*yi1+β1*yi1),(y2 – β1*yi1+β1*yi1),, (yi1-β1*yi1+β1*yi1),…,(yN1- β1*yi1+β1*yi1))

Y1 = (y1, y2,…, yi1,…, yN1). … (7)

Step5: Calculate FFT for y1, and finally IFFT is performed which gives the actual data block

The flow diagram for receiver are described in flow diagram below:

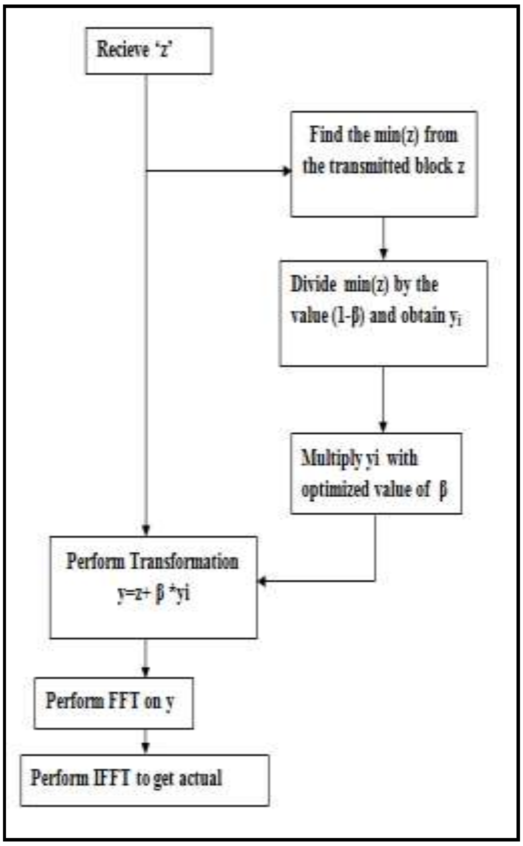


Fig 4. Flow diagram of RCMN algorithm at the RECEIVER side

V. SIMULATION RESULT:

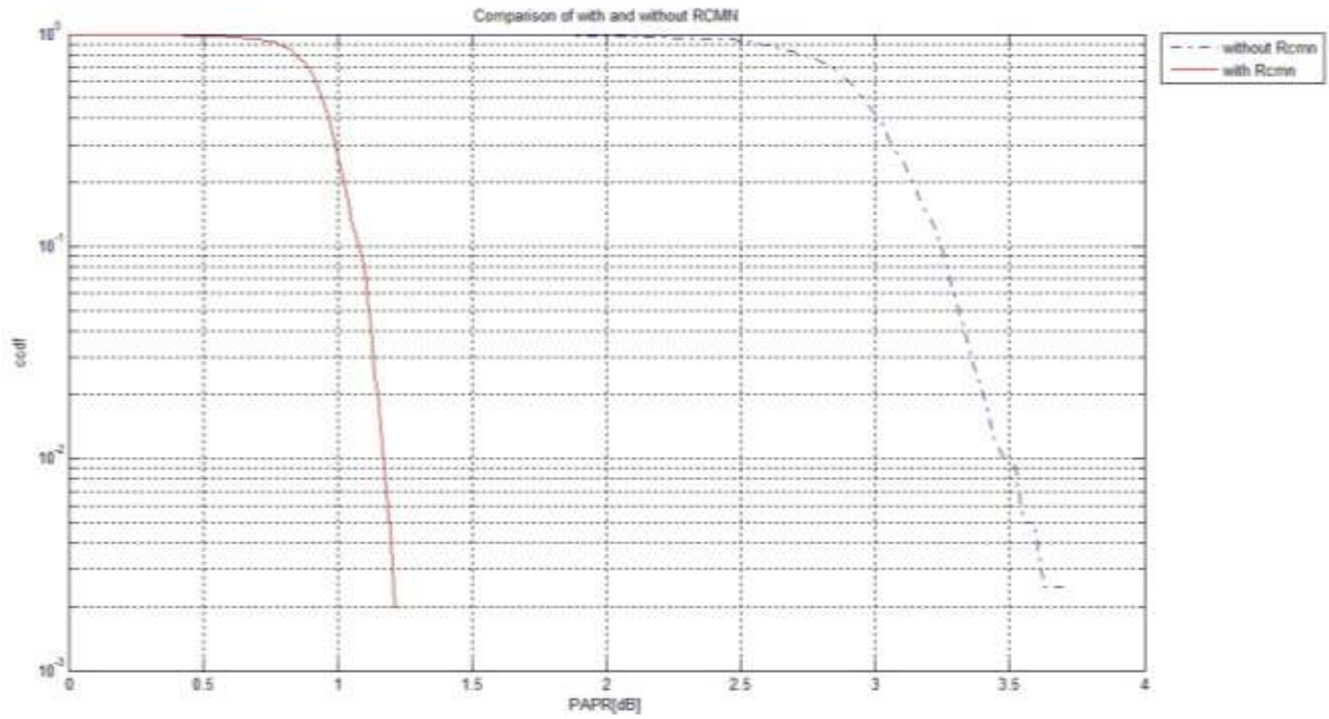


Fig 5 .Comparison of CCDF plot of PAPR with and without RCMN in SC-FDMA

The reduction in papr is evaluated and compared by doing the simulations in MATLAB using complementary cumulative distribution Function (CCDF). CCDF show how much time the signal remains at or above the given power level. Here CCDF is probability such that PAPR exceeds certain value (PAPR0) which is simulated. CCDF plot of PAPR values for IFDMA system with RCMN technique is compared with that of the IFDMA system without using RCMN technique. We have used the parameter β1 which adjusts the PAPR of the transformed output. The optimum value of β1 ranges from 2 to 5.The average power value depends on the parameter β1. If β1 increases the PAPR value reduces but which increases the average power value. This increase in average power value affects the system performance so average power should be limited by certain value. Hence the optimum value of β1 is selected as 3.

VI. CONCLUSION

In this paper we analyzed the PAPR of the IFDMA system by using Reduced Complexity max Norm algorithm. It is seen from the simulation results that the RCMN method offers better peak power reduction performance than the IFDMA system without using RCMN technique. One of the main advantages of the proposed method is that it can reconstruct the original signal using one-to-one transform property at the receiving side. Hence it is not required to transmit side information (SI) to reconstruct the signal at the receiving side. The given method works effectively for higher data rates and suitable for high speed wireless systems.

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