Selective Mapping Algorithm Based LTE System with Low Peak to Average Power Ratio in OFDM

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ABSTRACT - To propose a high performance LTE system. The performance of an LTE system is enhanced in two stages. The first stage is to reduce the high peak to average power ratio of the OFDM signal. The second stage is to improve the channel estimation. PAPR reduction is based on the selective mapping algorithm. The channel estimated via least square method by using wavelet-based de-noising method to reduce additive white Gaussian noise and inter-carrier interference (ICI).OFDM system suffer with the problem of inherent high peak-to-average power ratio (PAPR)due to the inter symbol interference between the subcarriers. In order to obtain an optimal PAPR reduction using the selective mapping algorithm with less complexity. The proposed system used to reduce the PAPR and improved bit error rate in OFDM.

Keyword: OFDM(orthogonal frequency division multiplexing),PAPR(Peak to average power ratio),SLM(selective mapping algorithm),CP(cyclic prefix)

1 INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is a Multicarrier transmission technique based on orthogonal carriers which have become one of the most cheering developments of modern broadband wireless networks and wire line digital communication systems because of its high speed data transmission, great spectral efficiency, high quality service, robustness to the selective fading problem and narrow band interference. High Peak-to-Average Power Ratio (PAPR) of transmitted OFDM signals is one of the major problems . High PAPR in OFDM system leads to used High Power Amplifier (HPA) with a large dynamic range, but these amplifiers are very expensive and are major cost component of the OFDM system. OFDM is widely applied to mobile communication systems due to its robustness against the frequency selective fading channel and high data rate transmission capability.

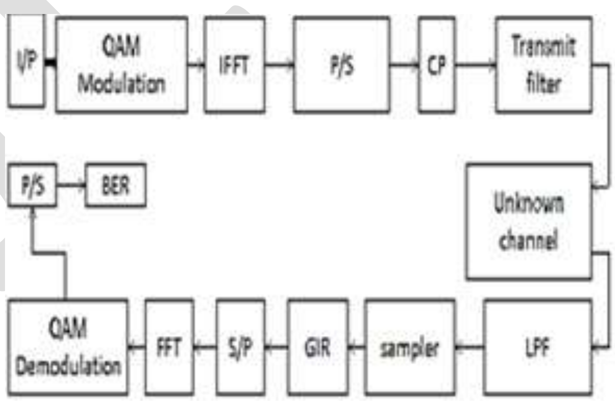

Fig.1, OFDM Block diagram

In an OFDM scheme a large number of sub-channels or sub-carriers are used to transmit digital data. Each sub-channel is orthogonal to every other. They are closely spaced and narrow band. The separation of the sub-channels is as minimal as possible to obtain high spectral efficiency. OFDM is being used because of its capability to handle with multipath interference at the receiver. These two are the main effects of multi propagation. Frequency selective fading and Inter Symbolic Interference (ISI). In OFDM the large number of narrow band sub-carriers provides sufficiently "flat" channels. Therefore the fading can be handled by simple equalizing techniques for each channel. Furthermore the large amount of carriers can provide same data rates of a single carrier modulation at a lower symbol rate.

2 PEAK TO AVERAGE POWER RATIO

One of the most serious problems with OFDM transmission is that, it exhibits a high peak-to-average ratio. In other words, there is a problem of extreme amplitude excursions of the transmitted signal. The OFDM signal is basically a sum of N complex random variables, each of which can be considered as a complex modulated signal at different frequencies. In some cases, all the signal components can add up in phase and produce a large output and in some cases, they may cancel each other producing zero output. Thus the peak-to-average ratio (PAR) of the OFDM system is very large.

The problem of Peak-To-Average Ratio is more serious in the transmitter. In order to avoid clipping of the transmitted waveform, the power-amplifier at the transmitter front end must have a wide linear range to include the peaks in the transmitted waveform. Building power amplifiers with such wide linear ranges is a costly affair. Further, this also results in high power consumption. The DAC's and the ADC's must also have a wide range to avoid clipping.Due to the large number of sub-carriers in typical OFDM systems, the amplitude of the transmitted signal has a large dynamic range, leading to in-band distortion and out-of-band radiation when the signal is passed through the nonlinear region of power amplifier.Although the above-mentioned problem can be avoided by operating the amplifier in its linear region, this inevitably results in reduced power efficiency. Peak to average power ratio reduces the accuracy and produce a high error rate. Various PAPR reduction techniques can be used in OFDM.
The PAPR of the transmit signal is defined as

$$\text{PAPR}=\frac{\max_{0\le t\le T}|x_k|^2}{\frac{1}{T}\int_0^T |x_k|^2 dt}$$

From the central limit theorem; for large number of N, the real and Imaginary values of S(t) become Gaussian distributed.

The amplitude of PAPR, is therefore has a Rayleigh distribution, with zero mean and variance N times the variance of one complex sinusoidal signal.

3 SELECTIVE MAPPING METHOD

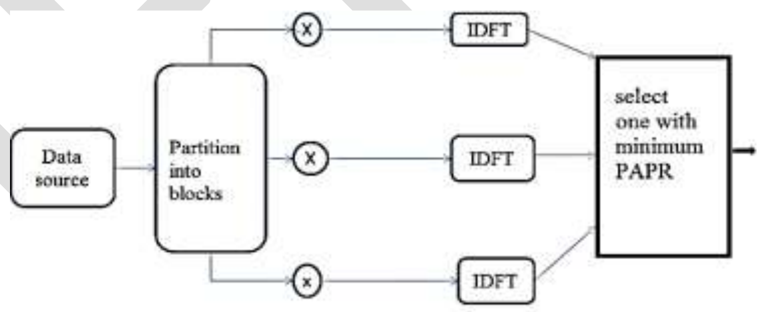

Fig.2:block diagram for SLM

Selected mapping (SLM) is a promising PAPR reduction technique of OFDM system. The main idea of SLM technique is to generate a number of OFDM symbols as candidates and then select the one with the lowest PAPR for actual transmission from a number of different data blocks (independent phase sequences) that have the same information at the transmitter. In the SLM method, the vectors from the original frequency domain OFDM signal are rotated based on a set of predefined phase arrays. For each signal variant obtained, its corresponding PAPR is evaluated. The one with the lowest PAPR is chosen for the transmission. The block diagram of SLM scheme is demonstrated in Fig 2

4 PROPOSED BER SCHEME

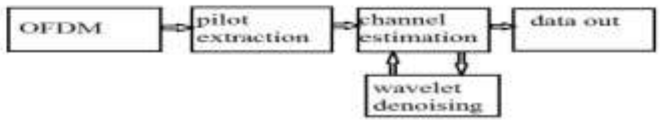

Fig.3:Proposed scheme

OFDM is widely applied in mobile communication due to robustness against the frequency selective fading channel and high data rate transmission.Pilot extraction method was used to prevent frequency and phase shift errors.Channel estimation technique of an OFDM system can be grouped into two categories. Blind and non-blind. The blind channel estimation method exploits the statistical behavior of the received signals, while the non-blind channel estimation method utilizes some or all portions of the transmitted signals,i.e., pilot tones or training sequences, which are available to the receiver to be used for the channel estimation.

In non-blind method there are two classical pilot-based channel estimation algorithms namely LS (Least Square) and MMSE (Minimum Mean-square error) estimation. Since LS estimation is simpler to implement as it doesn't need any information about channelstatistics, LS estimation has been widely used .However ,LS estimation is sensitive to additive white Gaussian noise(AWGN), especially, when the signal-to-noise ratio (SNR) is low, the performance will degrade significantly. MMSE estimation is more robust against noise and performs better than LS.

Wavelet Denoising is a method to remove the noise contained in the LS estimation. To reduce the additive white Gaussian noise and inter carrier interference. The general wavelet denosing procedure is as follows:

[1] Apply wavelet transform to the noisy signal to produce the noisy wavelet coefficients at stable required level.

[2] Select appropriate threshold limit at each level and threshold method (hard or soft thresholding) to best remove the noises.

[3] Inverse wavelet transforms of the thresholded wavelet coefficients to obtain a denoise signal.

The channel estimation can be performed by either inserting pilot tones into all of the subcarriers of OFDM symbols with a specific period or inserting pilot tones into each OFDM symbol .The first one, block type pilot channel estimation, has been developed under the assumption of slow fading channel. Even with decision feedback equalizer, this assumes that the channel transfer function is not changing very rapidly. The estimation of the channel for this block-type pilot arrangement can be based on Least Square (LS) or Minimum Mean-Square (MMSE).The MMSE estimate has been shown to give 10–15 dB gain in signal-to-noise ratio (SNR) for the same mean square error of channel estimation over LS estimate

5 SIMULATION RESULT

This simulation is based on LTE Standard. In this section, the computer simulations, using MATLAB, are capability of the proposed scheme.

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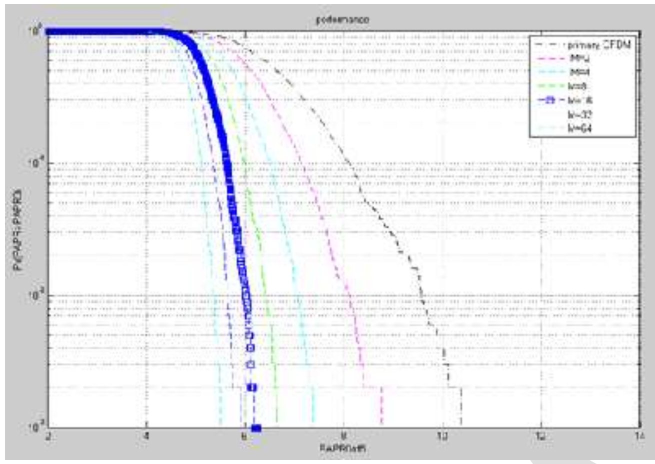

Fig .5: PAPR Reduction

OFDM system parameters used in the simulation are indicated in Table I. We assume to have perfect synchronization

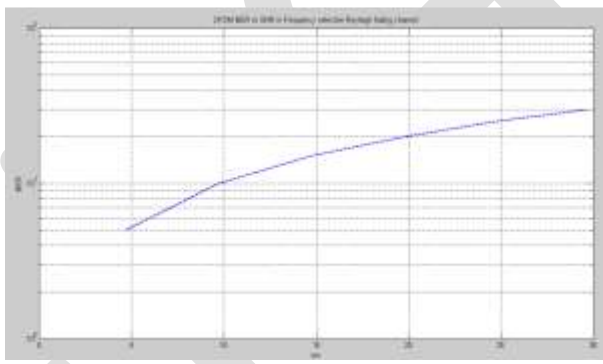

Fig.6: BER rate calculation

since the aim is to observe channel estimation performance. Moreover, we have chosen the guard interval to be greater than the maximum delay spread in order to avoid inter-symbol interference. Simulations are carried out for different signal-to noise(SNR) ratios. The simulation parameters to achieve those results are shown in the table.1

Table .1: System parameter

Parameters	Values used
Number of sub carriers(N)	64
Oversampling factor(OF)	8
Modulation scheme	QAM
Number of sub blocks used in SLM	2,4,8,16,32,64
Total Number of IFFT for weighted factor 1(or)2	256

6 CONCLUSION

To propose a modified OFDM scheme with high performance. The proposed scheme achieved low PAPR and low BER based on the LTE system. The improvement of the PAPR is achieved by selective mapping, where trigonometric transformation with minimum PAPR is selected for each partitioned block. On the other hand, the improvement of BER is achieved by the enhancement of channel estimation which is based on enhanced least square estimator by using wavelet based de-noising method to reduce additive white Gaussian noise and inter-carrier interference (ICI).

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