MODIFIED ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING

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ABSTRACT

The main drawbacks of OFDM are high PAPR and inter symbol interference. The selected mapping technique is one of the most popular PAPR scheme for OFDM system. The present scheme, which is used to reduce PAPR, is SLM. In SLM scheme, the modulated information is multiplied with different phase sequences and finally we select the phase-multiplied data with minimum PAPR. The main drawbacks of SLM technique are computational complexity and the need for transmission of several side information bits for each data block which causes reduction of data rate. In the proposed method the side information embeds in predefined phase sequence and predefined phase sequence transmitted in side lobe. The receiver is designed in such a way that it receives all the multipath signals, then it does the time scaling to arrange all the multipath signals and finally it averages all the time scaled multipath signals. The Proposed technique is Improved SLM (ISLM). The decoding computational complexity of ISLM is much lower than that of the SLM. The simulation results show the PAPR reduction performance and ISI reduction performance in multipath channel verses AWGN channel by using ML technique at the receiver.

Keywords*: *OFDM, PAPR, ISI, SLM, ISLM, BER, AWGN, ML.

I INTRODUCTION

The Orthogonal Frequency Division Multiplexing can support high data rate and provide high reliability in voice, data, and multimedia communications, and has been widely used for many wireless communication systems due to its high spectral efficiency and robustness to the frequency selective fading channels [1]. The main critical drawbacks of OFDM are the high peak to average power ratio (PAPR) of the output signal which results in significant inter-modulation and undesirable out-of-band radiation when an OFDM signal passes through nonlinear devices [2]. Inter Symbol Interference (ISI) which results low Signal to Noise Ratio (SNR). Several techniques have been proposed to reduce the PAPR of OFDM signals [3]-[10]. Clipping is used to reduce the peak power by clipping the OFDM signals to the threshold level but it causes in-band distortion and out-of- band radiation [3]-[5]. Coding technologies[6] to avoid sending those high PAPR code word appears don't cause signal distortion, but limited by the coded modulation, bounded by the number of sub-carriers because most of the coding methods introduce a certain amount of redundant information. Distortion less techniques[7]-[10] including selected mapping (SLM) and partial transmit sequence (PTS) select the signal with the minimum PAPR among several candidate signals generated by multiplying phase sequences to the data sequence before or after inverse fast Fourier transform

(IFFT).The selected mapping (SLM) technique select the signal with the minimum PAPR among several candidate signals generated by multiplying phase sequences to the data sequence before or after inverse fast Fourier transform (IFFT). The selected mapping (SLM) doesn't cause in-band distortion and out-of-band-radiation. The main drawbacks of this method are high computational complexity and extra information sent to the receiver reducing the spectral efficiency. To avoid the information rate loss caused by the transmission of extra information a new technique is employed. The new technique is Improved Selected Mapping (ISLM). In the proposed method the side information embeds in predefined phase sequence and predefined phase sequence transmitted in side lobe. The receiver is designed in such a way that it receives all the multipath signals, then it does the time scaling to arrange all the multipath signals and finally it averages all the time scaled multipath signals. In this paper we propose a performance of improved SLM method under multipath channel in OFDM System.

II OFDM AND PAPR OF OFDM & SLM

a. OFDM Signal:

In an OFDM system, the transmitted signal in time domain is

$$x_n = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k e^{j2\pi n} \qquad (1)$$

Where N is the number of sub-carriers, and X= $\{x_k\}$ (k=0, N-1) is the input modulated data symbols.

b. The PAPR of OFDM&SLM:

The PAPR of OFDM signal x_n is defined as

$$\text{PAPR}= 10\log_{10} \frac{\max\{|xn|^2\}}{E[|xn|^2]} (\text{dB}) \qquad (2)$$

Where E[.] represents the expectation.

In the SLM scheme, to generates U different phase sequences of length N

$$p^{(u)} = [p_0^{(u)}, p_1^{(u)}, \ldots\ldots, p_{N=1}^{(u)}] \qquad (3)$$

Where (u=1,2,……,U), $p_i^{(u)} = \exp(j\varphi_i^{(u)})$. The first phase sequences are usually the all-1 sequences. Then, the alternative symbols sequences generated.

$$X^{(u)} = \langle X \bullet p^{(u)} \rangle = [x_0 p_0^{(u)}, x_1 p_1^{(u)}, \ldots\ldots, x_{N-1} P_{N=1}^{(u)}] \qquad (4)$$

After U alternative symbol sequences are transformed by IFFT, Correspondingly U different output sequence obtain

$$x^{(u)} = IFFT(X^u) = [x_0^{(u)}, x_1^{(u)}, \ldots \ldots x_{N-1}^{(u)}] \qquad (5)$$

$x^{(u^*)}$ with the smallest PAPR is selected for transmission:

$$x^{(u^*)} = \arg\,[10\log \frac{\max\{|x_n|^2\}}{E\{|x_n|^2\}}] \qquad (6)$$

If we assume that the output sequences (5) are mutually independent, the complementary cumulative distribution function (CCDF) of PAPR for the SLM scheme can be given as

$$\text{pr}(\text{PAPR}(x^{(u)}) > PAPR_0) = (1-(1-e^{-PAPR_0})) \qquad (7)$$

It is shown that the alternative OFDM signal sequences are asymptotically mutually independent if the phases of symbols in each phase sequence are independent and identically distributed with zero expectation value, and the SLM scheme satisfying this condition can have the optimal PAPR reduction performance.

III IMPROVED SLM

As described above, the alternative symbol sequences (4) are generated, $x^{(u)}$is divided by a certain partitioning scheme into L disjoint sub-sequences $[X_1^u, X_2^u, \ldots\ldots\ldots, X_L^u]$,

$$X_v^u = [X_{\frac{N(v-1)}{L}} P_{\frac{N(v-1)}{L}}, X_{\frac{N(v-1)}{L}+1} P_{\frac{N(v-1)}{L}+1}, X_{\frac{NV}{L}-1} P_{\frac{NV}{L}-1}] \quad (8)$$

V=[1,2,…….,L].Then, every data block multiplied by the different predefined phase sequence

$$W_u = [w_1^u, w_2^u, \ldots\ldots\ldots, w_L^u] w_v^u \in (0,1) \quad (9)$$

Now $$x^{(u)} = [x_1^u e^{j\theta w_1^u}, x_2^u e^{j\theta w_2^u}, \ldots\ldots\ldots x_L^u e^{j\theta w_L^u}] \quad (10)$$

The side information embedded in different predefined phase sequence D_u showed in figure 4. Respectively for fast inverse Fourier transform

$$x^{(u)} = \text{IFFT}(x^{(u)}) = \sum_{v=1}^{v} IFFT(x_v^u),$$

We can get $x_k^{(u)} = \frac{1}{\sqrt{N}} \sum_{k=0}^{N=1} x_k \, e^{j^{\sim}xn}$. The candidate with the lowest PAPR is chosen by exhaustive search of the candidates for transmission,$x^{(U^{\sim})}$=arg min(10 log$\frac{\max\{|x_n|^2\}}{E\{|x_n|^2\}}$).

After the IFFT demodulation at the receiver, the received symbol

$$R_n^{(u^{\sim})} = G_n X^{(u^{\sim})} + N \quad (11)$$

where $G_n$is the frequency response of the channel at the n-th sub-carrier and N is an addictive white complex Gaussian noise (AWGN) sample at the n-th sub-carrier.

Without the side information (u˜) , the optimal ML decoder computes the decision metric for decoding the received symbol sequence R. the optimal metric of the ML decoder is given as Expression:

$$D_{v,w_k^u} = \sum_{n=(v-1)\frac{N}{L}}^{\frac{N}{L}-1} \min \left| R_n^{(u^{\sim})} e^{-j\theta w_v^u} - G_n X^{\sim}_n \right|^2 \quad (12)$$

Where v=[1,2,…..,L]$w_v^u \in (0,1), x^{\sim}_n$ is a constellation point of s_0.

After the calculation, the ML decoder may calculate and de rotate the alternative symbol sequence by a decision metric and finally decides an input symbol sequence, the decision metric being given as

$$D_{u^{\sim}} = \min_{w_v^u} \sum_{v=1}^{L} D_{v,w_v^u} \quad (13)$$

With this configuration, the invention provides a novel ISLM with low decoding complexity. As compared with a conventional method, detection failure of side information can be decreased.

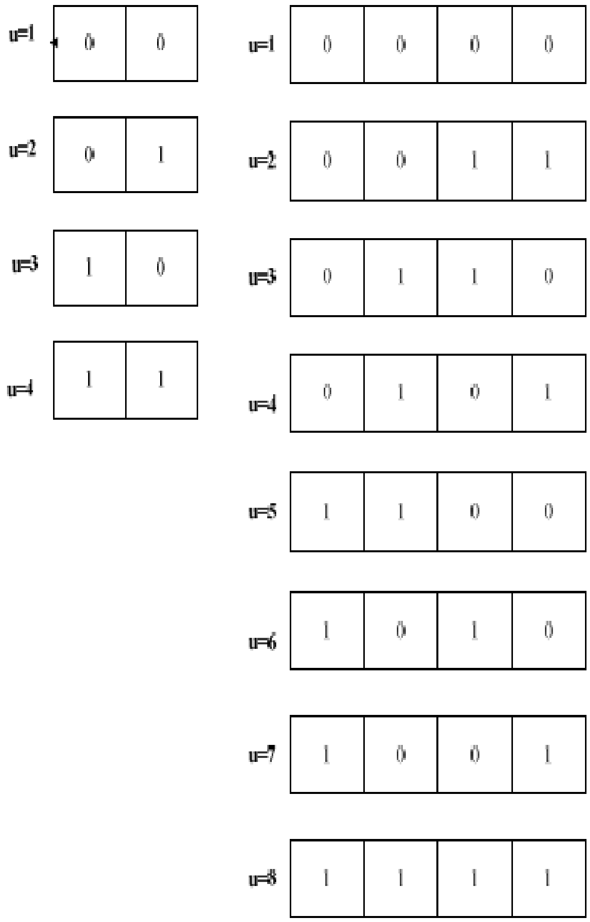

Fig 4: U=4 and U=8

Gaussian channel as the ideal channel, the channel impulse response is set to 1 ($G_n = 1$). Under multipath channel, the channel impulse response is obtained by the channel estimation. In TD-LTE system, a frame which starts with a preamble is formed by several OFDM symbols. In this paper the PAPR reduction is not performed on the preamble, because we assume that the PAPR of preamble is sufficiently low. So the channel response could be estimated during the preamble period and be used at the next OFDM symbol if we choose the channel which is changed slowly. The channel response of subsequent OFDM symbols could be obtained by using the iteration method.

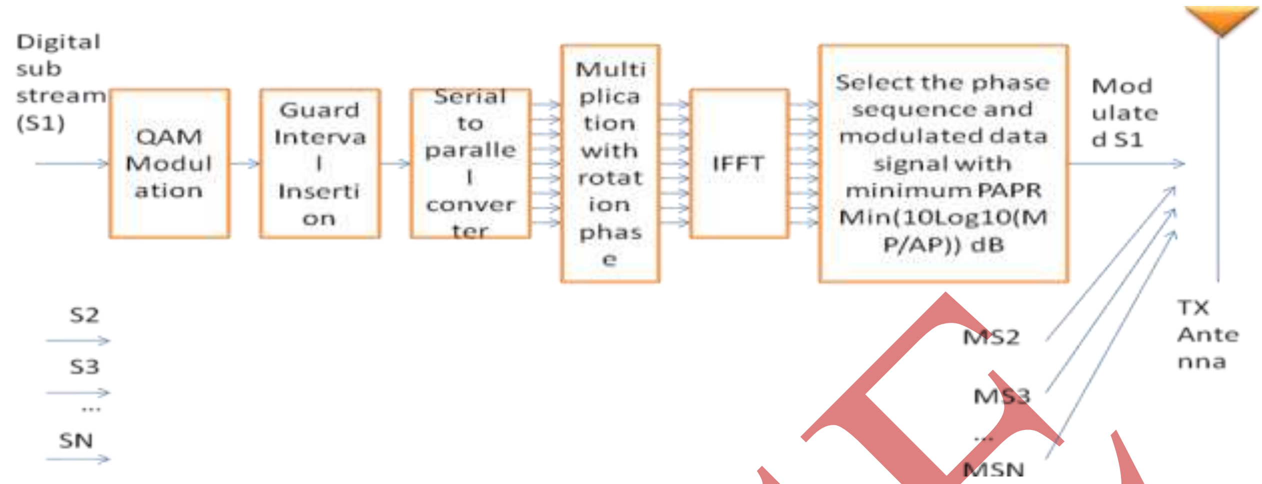

Fig 5: Transmitter of Improved Selected Mapping

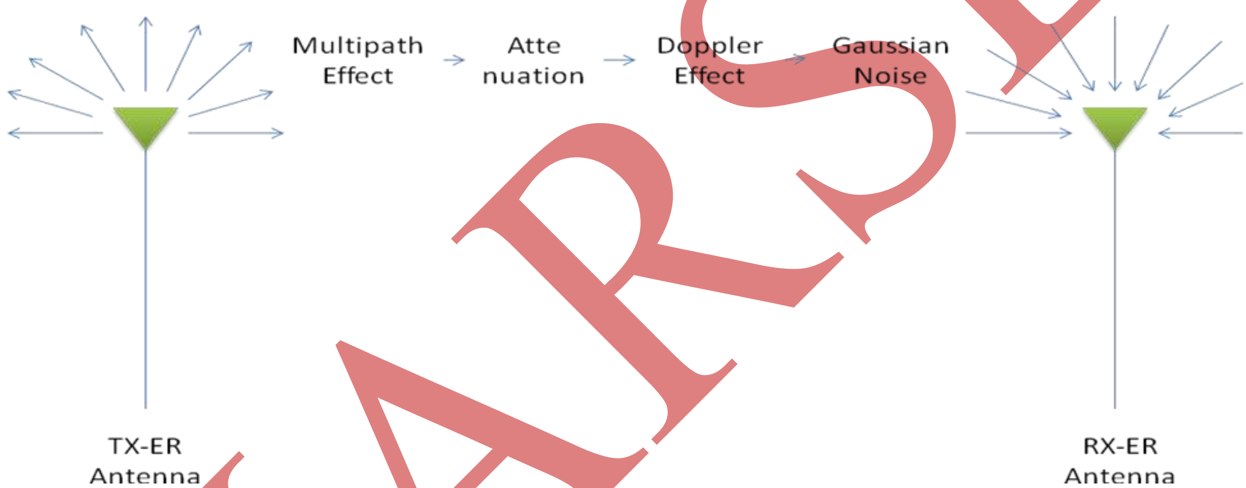

Fig 6: Wireless Communication Channel

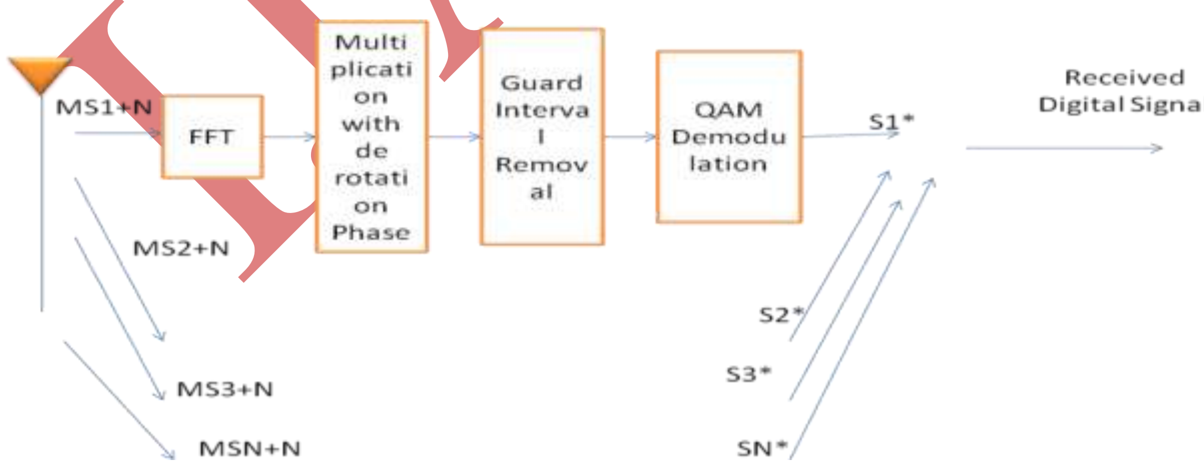

Fig 7: Receiver of Improved Selected Mapping

IV RESULTS AND DISCUSSIONS

In this section the results obtained through the simulations are brought. The results are given here in terms of PAPR-CCDF and SNR-BER criteria for SLM and ISLM with U =8(U stands for the number of reuse of original sequences in the SLM algorithm). Constellation is chosen to be QAM with 128 sub-carriers per symbol. For the SLM, the first group of phase sequence is created using {+1,-1+j,-j}. The following sub-block phase sequence shown in Figure 4. In the following the performance of the system for both conventional SLM and ISLM under AWGN channel compared to multipath fading channel are examined.

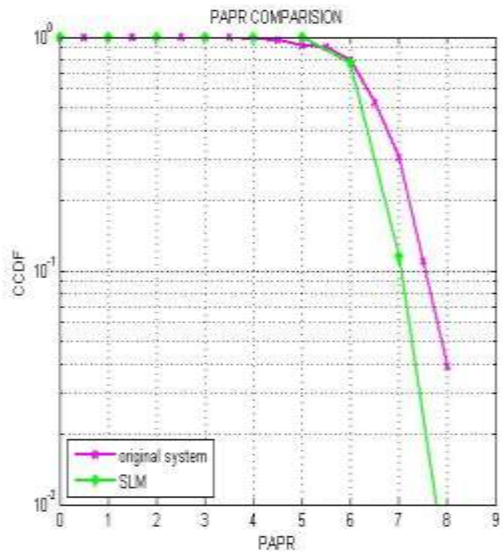

Fig 8: PAPR-CCDF of SLM and original OFDM signal

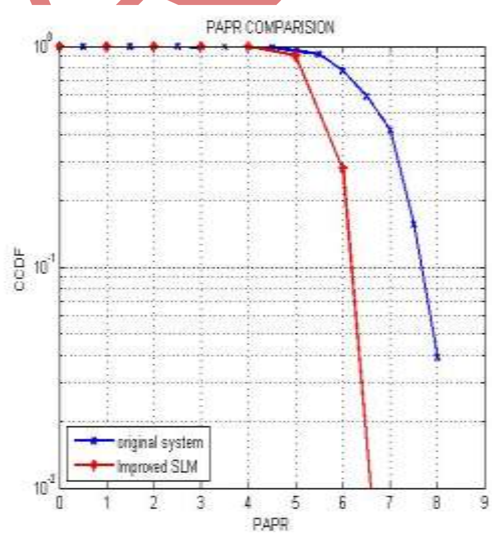

Fig 9: PAPR-CCDF of improved SLM and Original OFDM signal

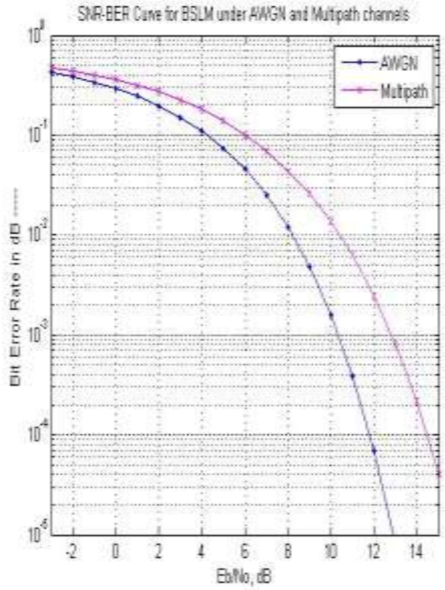

Fig 10:- SNR-BER of improved BSLM under AWGN channel and multipath channel

V CONCLUSIONS

The improved ISLM which further reduces the PAPR of the OFDM system further has presented. Both the transmitter and receiver have the predefined sub-block phase sequences. In view of the conventional ISLM, the computational complexity of decoding reduces exponentially. By inserting pilot channel estimation, this method of transmission the multipath channel does not cause serious BER. Under the higher SNR, BER is almost the same level in the Gaussian channel.

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