A DIFFERENTIAL SUBCARRIER ENCODED HYBRID SLM-PTS SCHEMES FOR PAPR REDUCTION IN THE OFDM SYSTEMS

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Abstract:

Orthogonal Frequency Division Multiplexing (OFDM) is an efficient method of data transmission for high speed communication systems. However, the most disadvantage of OFDM system is that the high Peak to Average Power Ratio (PAPR) of the transmitted signals. OFDM carries with it sizable amount of number of independent subcarriers, as a results of that the amplitude of such a symptom will have high peak values. To reduce PAPR, in this paper introduced hybrid algorithm, i.e. combination of selective mapping (SLM) and partial transmit sequence (PTS) is used. It gives the better PAPR reduction performance and reduces computational complexity compared with the conventional hybrid scheme. As a result, with the same numbers of IFFT and phase rotation sequences, our proposed algorithm has the potentials to produce better PAPR reduction performance with lower computational complexity, here the differentially encoded subcarriers makes the algorithm a low PAPR performance in the system.

INTRODUCTION:

In the recent years Orthogonal Frequency Division Multiplexing (OFDM) technology has become a key technology for future communication systems and area unit presently attracting intensive attention in wireless communications and wire communications to satisfy the advancement that are tired the multimedia system technology and broadband services. OFDMA-based systems are unit able to execute high information rates, will exploit with multipath propagation, offer hardiness against frequency selective weakening or narrowband interference, OFDM is very promising alternative for future mobile communication systems. OFDMA has been employed in IEEE 802.16, Wi-max, 3GPP Long Term Evolution (LTE) downlink, and advanced long run Evolution [1].

Multicarrier modulation could be a technique that has high knowledge rates and also the orthogonality in OFDM system indicates that there's a mathematical relationship between the frequencies of the carriers within the system. On the opposite hand, in FDM system, the carriers ar spaced apart with guard bands in such how that guard bands ar introduced between the different carriers within
the frequency domain, which ends in lowering spectrum potency [2].

To reduce the PAPR, many techniques are fictitious [3] that primarily are often divided in 3 classes. First of all, signal distortion techniques that scale back the height amplitudes by merely nonlinearly distorting the OFDM signal at or round the peaks ex: Clipping [4], second there square measure cryptography techniques that use DWT, DCT and DHT to lower PAPR. The third techniques scrambles every MC-CDMA (OFDM) image with completely different scrambling sequences and chooses the sequence that provides smallest PAPR [5].

In this paper, we use SLM, PTS techniques for PAPR reduction in MC-CDMA system. we tend to investigate the Hybrid technique that is combination of PTS and SLM technique and so MC-CDMA signal is obtained and reduced PAPR parameter is shown in simulation results.

**OFDM SYSTEM MODEL**

Let us define N frequency domain signals in OFDM as \( \{X, k = 0, 1, 2 ... , N-1\} \). These N signals construct 1 OFDM block. A set of N subcarriers i.e multicarrier signal is the sum of many independent signals modulated onto sub channels of equal bandwidth. Let us denote the collection of all data symbols, \( X_k \), where \( n \), \( 0,1, ... \) , N-1 , as vector[4]

\[
X = \begin{bmatrix} X_0 & X_1 & \cdots & X_{n-1}\end{bmatrix}^T
\]

That will be termed a knowledge block. The complicated baseband illustration of a multicarrier signal consisting of N subcarriers, ts is symbol duration. The OFDM signal is expressed as

\[
x(t) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} x(k)e^{j2\pi\frac{k}{N}t}, \quad 0 \leq t \leq Nt_s
\]

A discrete-time OFDM model with \( N \) subcarriers is considered. With the linear property of the \( N \) narrowband subcarriers, the discrete-time OFDM signals can be written as

\[
x(k) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k e^{j2\pi kn/N}, \quad n = 0,1, ... N-1
\]

The PAPR is defined as

\[
PAPR = \frac{\min_{0<n<N-1} |x(n)|^2}{E\{|x(n)|^2\}}
\]

Where \( E\{.\} \) denotes expectation operator. In the literature, the complementary cumulative distribution function (CCDF) [6] of the PAPR is one among the foremost often used performance measures for PAPR reduction techniques. The CCDF of PAPR denotes the probability that the PAPR of an OFDM symbol exceeds a given threshold \( \gamma_0 \), that is, the CCDF of PAPR is written as

\[
CCDF_\gamma(\gamma_0) = \text{prob}\{\text{PAPR}_y > \gamma_0\}
\]

In general, OFDM systems with Gaussian time domain samples, so the CCDF of PAPR can be written as

\[
\text{prob}\{\text{PAPR}_y > \gamma_0\} = 1 - (1 - e^{-\gamma_0})^N
\]

**CONVENTIONAL HYBRID SCHEME**

In the starting, conventional hybrid (CH) methodology combining the SLM with PTS schemes is investigated. The strategy was initial expressly projected by P. A Pushkarev in [12]. The diagram of the CH
methodology is shown in Fig. 1. The original OFDM symbol is increased with the U phase rotation sequences, so every of the new OFDM symbols is partitioned off into V pair wise disjoint sub-blocks. Those OFDM sub-block values square measure calculated by every improvement of PTS blocks [7]. For simplicity and while not loss of generality, V = 2 a pair of is often thought of during this paper. Every signal \( \hat{x}(u) \), where \( u = 1 \ldots U \), with rock bottom PAPR is chosen by every improvement block. They’ll be written as

\[
\left\{ b_1^{(u)}, b_2^{(u)} \right\} = \arg\min_{\left\{ b_1^{(u)}, b_2^{(u)} \right\}} \left\{ \sum_{v=1}^{2} b_v^{(u)} x_v^{(u)} \right\}
\]

(6)

\[
\hat{x}^{(u)} = \sum_{v=1}^{2} b_v^{(u)} x_v^{(u)}
\]

(7)

where \( 1 \leq u \leq U \).

By the selection block, the relatively lower PAPR can be obtained from those lowest PAPR values of each PTS block [7]. Because those lowest PAPR values of each PTS blocks are statistically independent to each other, the CCDF of CH scheme can be written as

\[
\text{CCDF}_{\text{CH}} = (\text{prob}\{\text{PAPR}_{\text{PTS}} > \gamma_0 \})^{U}
\]

(8)

In order to recover transmitted data information, the receiver must have the knowledge of side information. Because the CH signal must include the side information of SLM and the side information of PTS, the number of required side information bits can be written as

\[
N_{\text{CH}} = \log_2 U + (V - 1) \log_2 W
\]

(9)

where \( W \) is the number of allowed phase rotation factors. In (8), the first term expresses the SLM required side information bits and the second term is the additional bits from the PTS algorithm.
PROPOSED HYBRID SCHEMES

A. Additional hybrid scheme

In order to boost the PAPR reduction performance in CH theme, we’ve got to come up with an outsized variety of other OFDM signal sequences while not increasing the amount of IFFT to avoid high procedure quality. Here, a new additional hybrid (AH) theme by combining the changed SLM theme with CH theme. The system performance is desirable that the amount of IFFT is reduced however the PAPR reduction performance isn’t compromised. The diagram of AH theme is shown in Fig. 2.

Clearly, the primary U signals \( \hat{x}^{(u)} \), wherever \( u = 1, \ldots, U \), square measure an equivalent because the signals (7) within the CH theme. moreover, the alternative OFDM signal sequences square measure generated by the linear combination of the sub-block signals from totally different PTS blocks when IFFT operation. Victimization the linear property of Fourier rework, the linear combination of those sequences is obtained by

\[
X^{(u)}_v = c^{(i)} X^{(i)}_v + c^{(k)} X^{(k)}_v \tag{10}
\]

Where \( U+1 \leq u \leq U^2 \), \( 1 \leq i \), \( k \leq U \), \( 1 \leq v \leq 2 \). And \( c^{(i)} \) and \( c^{(k)} \) are some coefficients to be chosen later. that's to say, if we've OFDM signal sequences \( X^{(i)}_v \) and \( X^{(k)}_v \), the other different OFDM signal sequences in (10) are often obtained without acting IFFT operation.
Now, we would investigate a way to build every element of $X^{(i)}_v$ and $X^{(k)}_v$ to possess unit magnitude underneath the condition that every element of the phase sequences $P^{(1)}$ and $P^{(k)}$ has unit magnitude. Basically, the weather of the sequence $X^{(i)}_v$ and $X^{(k)}_v$ have unit magnitude if the following conditions are satisfied

- $c^{(i)} = \pm \left(\frac{1}{\sqrt{2}}\right)$ and $c^{(k)} = \pm \left(\frac{1}{\sqrt{2}}\right) j$, and
- Each element of $P^{(i)}$ and $P^{(k)}$ takes the value in $\pm 1$.

Since $|c^{(i)}|^2 = |c^{(k)}|^2 = 1/2$, the common power of $X_v^{(u)}$ is capable one half the add of average power of $X^{(i)}_v$ and $X^{(k)}_v$. From $U$ binary part rotation sequences, we are able to get combine of $2 \binom{U}{2}$ excessive pair sub-blocks sequences, thus, there are total $U^2$ try sub-blocks sequences for AH theme. Then, the choice OFDM signal of lowest PAPR in AH theme can be written as

\[
\{\hat{b}^{(u)}_1, \hat{b}^{(u)}_2\} = \arg\min_{\{b_1^{(u)}, b_2^{(u)}\}, x^{(u)}_1, x^{(u)}_2} b^{(u)}_1, x^{(u)}_1 + b^{(u)}_2, x^{(u)}_2
\]

(11)

\[
\tilde{x}^{(u)} = \hat{b}^{(u)}_1, x^{(u)}_1 + \hat{b}^{(u)}_2, x^{(u)}_2
\]

(12)

Where $U + 1 \leq u \leq U^2$.

We have to select and transmit the ensuing OFDM signal sequence $\tilde{x}$, that has the minimum PAPR among the whole OFDM signal sequences of overall lowest PAPR $\tilde{x}^{(u)}$ sequences, that square measure composed by $\{x_1^{(u)}, \ldots, x_u^{(v)}\}$ once every improvement operation. The quantity of required side info bits for transmitter can be written as

\[
N_{AH} = \log_2 U^2 + (V - 1) \log_2 W
\]

(13)

### B. Switching hybrid scheme

Instead of generating various OFDM sequences with linear combination, a replacement switching hybrid (SH) theme by combining the switching technique with the CH theme. The system performance is fascinating that the number of IFFT is reduced however the PAPR reduction performance is not compromised. The block diagram of SH theme is shown in Fig. 3.

By the switching block, we will use original $U$ pairs $\{x_1^{(u)}, x_2^{(u)}\}$ to generate excessive $2 \binom{U}{2}$ pairs of OFDM sequences without increasing the number of IFFT units. Thus, there are total $U^2$ $\{x_1^{(u)}, x_2^{(u)}, \ldots, x_1^{(u^2)}, x_2^{(u^2)}\}$ are operated by each optimization unit [8]. Obviously, the primary $U$ signals $\hat{x}^{(u)}$ where $u = 1, \ldots, U$ are the same because the signals (7) in the CH theme. after the optimization blocks, the opposite various OFDM sequences with lowest PAPR $\tilde{x}^{(u)}$ can be written as

\[
\{\hat{b}^{(u)}_1, \hat{b}^{(u)}_2\} = \arg\min_{\{b_1^{(u)}, b_2^{(u)}\}, x^{(u)}_1, x^{(u)}_2} b^{(u)}_1, x^{(u)}_1 + b^{(u)}_2, x^{(u)}_2
\]

(14)
\[ \hat{\chi}^{(u)} = \hat{b}_1^{(u)} x_1^{(i)} + \hat{b}_2^{(u)} x_2^{(k)} \]

(15)

Where \( U+1 \leq u \leq U^2 \), \( 1 \leq i, k \leq U \), \( i \neq k \). In equation (15) \( \chi_p^{(i)} \) and \( \chi_p^{(k)} \), \( i \neq k \) come from different PTS blocks, which are generated by different phase rotation sequences, so that \( P^{(1)} \) and \( P^{(k)} \), where \( 1 \leq i, k \leq U \), \( i \neq k \), can obtain differently alternative OFDM sequences with the minimum PAPR. Noteworthy, the number of required side information bits can be written as

\[ N_{Sh} = \log_2 U^2 + (V - 1) \log_2 W \]

(16)

### A. Modified hybrid scheme

In order to further improve the PAPR reduction performance while not increasing the amount of IFFT, the modified hybrid (MH) algorithmic rule is projected by combining AH and SH schemes to get additional and additional different OFDM sequences. Those \( \{x_1^{(u)}, x_2^{(u)}\} \) pairs, where \( 1 \leq u \leq U \), square measure the signal inputs of the additional block and switching block respectively and simultaneously. The block diagram of MH theme is shown in Fig. 4.

**Fig 3:** The block diagram of Switching Hybrid Scheme.
Using the linear property of Fourier transform, the linear combination of U phase rotation sequences can get excessive $2^{U_2}$ alternative OFDM sequences. Once optimization blocks, those overall lowest PAPR $\hat{x}^{(u)}$ may be written because the same as (12). Victimization the switch technique among PTS blocks, the signals of U phase rotation sequences can obtain excessive a pair of U a pair of alternative OFDM sequences. Once optimization blocks, those overall lowest PAPR $\hat{x}^{(u)}$ may be written because the same as (15).

In the MH scheme, if $V = 2$ and U phase rotation sequences are considered, the original signals $x_p^{(u)}$ can generate excessive a pair of U a pair of pairs of sequences respectively and simultaneously by either
extra block or switch block. Therefore, there are total $2U^2 - U$ OFDM sequences with the bottom PAPR in the MH scheme. In order to recover the transmitted information, the number of required side information bits can be obtained by

$$N_{SI} = \log_2(2U^2 - U) + (V - 1) \log_2 W$$

(17)

SIMULATION RESULTS:

Figure.1. The PAPR reduction performance of conventional hybrid with Differentially encoded subcarriers scheme

Figure.2. The PAPR reduction performance of additional hybrid with differentially encoded subcarriers scheme

Figure.3. The PAPR reduction performance of switching hybrid with Differentially encoded subcarriers scheme

Figure.4. The PAPR reduction performance of modified hybrid with Differentially encoded subcarriers scheme

CONCLUSION:

In this paper, the PAPR reduction performance becomes higher because the variety of $U$ will increase in CH theme, but the CH scheme has high procedure quality owing to the rise of the amount of IFFT. Therefore, supported original signals of CH theme, many powerful algorithms are
projected to enhance high PAPR reduction performance while not increasing the amount of IFFT, together with AH, SH and MH schemes. The MH theme will acquire the most effective PAPR reduction performance by combining the AH with SH schemes. After a number of comparative simulations, the MH theme has shown that the wonderful PAPR reduction performance may be achieved while not increasing the amount of IFFT. To sum up, the projected MH theme has obtained a superior PAPR reduction performance for OFDM systems.

The technique features a higher PAPR reduction performance by increasing the amount of different OFDM sequences. In particular, once the amount of IFFT is that the same, the MH scheme has the most effective PAPR reduction compared with CH, AH and SH schemes. Therefore, for the MH theme, it will expend less IFFT units to get similar PAPR reduction performance without the dramatic increase of aspect data bits. The extension to this project appending A new block or scheme Differential encoding subcarrier mapping we can get the improved PAPR value by seeing the result we can say that,in this method input signals are differentially sub carried by a parameter value $d$, by varying this parameter we get the varied results in the PAPR performance.

REFERENCES:


