Peak-To-Average Power Ratio Reduction in Polar Coded OFDM Signal in WiMAX Architecture

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Abstract. Peak to Average Power Ratio (PAPR) reduction technique for polar coded Orthogonal Frequency Division Multiplexing (OFDM) is introduced in WiMax Architecture was analyzed using Matlab Simulation Tool. The main idea is to use polar encoder in WiMax architecture which is one of the best encoder to choose the lowermost PAPR as a transmitted signal. This algorithm better showed efficiently reduced the peak to average power in the transmitted signal. It is suggested that the advised technique efficiently reduce the peak to average power distortion and as well as better bit error rate performance of the OFDM Signal. The simulation outputs are compared with various modulation techniques in relations to PAPR without degrading BER performance.

1. Introduction

Orthogonal Frequency Division Multiplexing (OFDM) accomplishes great spectral efficiency as well as stability against frequency selective fading channels. One of the main downsides of OFDM [3] is that the signal with the uppermost Peak-to-Average Power ratio (PAPR) which indications to severe impairment in associations of Power Amplifier (PA) inefficiency.

To regulate this challenging issues, numerous PAPR reduction procedures for OFDM systems have been proposed in a number of journals with a [12] Clipping and Filtering (CAF), [1] [6] Selective Mapping (SLM), [13] Partial Transmit Scheme (PTS) and some [4] coding schemes. Since, these methodologies have added in helpful the enactment of the OFDM systems in terms of BER and PAPR reduction.

In this paper, a PAPR can be reduced effectively in using WiMAX architecture [7] by polar coded OFDM system. At this point, in WiMAX architecture, the anew polar encoder [5] is presented. This process can improve the power amplifier effectiveness and to lessening PAPR distortion in OFDM signal. The Suggested model is based on a numerous signal producing methodology, wherever numerous signal for a transmitted OFDM signal are produced from different polar code words that share the same information, but with different random bits. The OFDM signal with the lowermost PAPR is then picks as a transmitted signal. Since all the data for a transported signal are created from different code words of the same polar code, and they can be deciphered by the same polar decoder, and thus no side data for recognizing the transmitted symbol is required. Also proposed a polar code [5] design is implemented in WiMAX architecture [7], where the positions of shaping bits are preferred based on their effect on PAPR reduction performance.

This paper not only recommends the polar coded design algorithm [5] and PAPR reduction, but also describes by using WiMAX architecture [7] for efficient reduction of PAPR. The key idea of this paper is shortened as follows:

- Implement a multi-candidate methodology to lessen PAPR of polar-coded OFDM [3] systems that does not need any side information.
- Suggest a WiMAX architecture and design algorithm for efficient reduction of PAPR polar codes.
- The proposed tactic displays that it gives an enhancement of more than 5 dB in PAPR output without increasing the recipient decoding complication [8].
2. System Description

Fig. 1 shows the proposed gadget model dependent on the polar encoded WiMAX design. To begin with, it produce a few pieces of the sign from a communicated OFDM on a V=2 premise, where I is the number of shaping bits. The \( u^{(v)} \) sequence pieces is encoded to create the code word \( c^{(v)} \) for every \( v \in \{1, 2, ..., V\} \) line. In this stage, all the solidified records have been set to zero by sharing data \( u_i^{(1)} = ... = u_i^{(V)} \) for \( I \in I \). Since, think about a polar code with code length \( n \) and measurement \( k \).

The subsequent number of solidified pieces is \( n-k \). Let \( u = (u_1, u_2, ..., u_n) \in F_2^n \) mean a twofold information vector to polar encoder, with its yield given by \( c = uF^{(\log_2 n)} \), where this condition is a (log)_2^n-overlap Kronecker intensity of the Arikan’s portion \( F = \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix} \) and \( c = (c_1, c_2, ..., c_n) \in F^n_2 \).

\( F_2^n \) is a code word. An info request to polar encoder \( u \) comprises of data bits and solidified pieces. We mean a lot of bit records in \( u \) where data pieces are doled out as \( I \in I \), whose cardinality is \( ||I|| = k \). Thus, a lot of solidified piece records is signified as \( F \). Each piece list in \( u \) has a place with either data or solidified sets, i.e., \( ||I \cup F|| = n \) and \( I \cup F = NULL \). The subsequent code pace of polar code is given by \( ||I||/||I \cup F|| = k/n \).

In this paper, an alternate arbitrary piece is created into the polar encoder and these pieces can be scrambled and it very well may be tweaked by utilizing QAM balance. For every \( v \in \{1, 2, ..., V\} \), the time space OFDM image \( s^{(v)} = (S_1^{(v)}, S_2^{(v)}, ..., S_{NL}^{(v)}) \in C^{LN} \) is created by relating opposite quick Fourier change (IFFT) to the regulated grouping \( x^{(v)} \) by an oversampling factor \( L \). The resultant OFDM image is communicated as \( S_t^{(v)} = \frac{1}{\sqrt{N}} \sum_{m=1}^{N} x_m^{(v)} e^{j2\pi mt/NL} \), for \( I \in \{1, 2, ..., NL\} \). The resulting PAPR on the OFDM symbol at the \( v \)th stream is set to

\[
PAPR^{(v)} = \frac{\max|s^{(v)}|^2}{\frac{1}{N} \sum_{i=1}^{NL} |s_i^{(v)}|^2}, \text{ for } 1 \leq i \leq NL
\]

3. Proposed Method

In the proposed method, we can reduce the PAPR and to achieve the error rate performances by using the WiMax architecture in polar coded design algorithm. It can also achieve a good PAPR reduction in our proposed method.
3.1 Randomizer

Randomization is done to dodge extensive successions of sequential "ones" or consecutives "zeros". On the off chance that the measure of information to communicate doesn’t fit precisely the measure of information designated, cushioning of 0xFF ("1" in particular) is added to the furthest limit of the transmission hinder, for the unused whole number bytes.

3.2 Polar Encoder

The size of the encoding square relies upon the quantity of allotted spaces and the balance characterized for the current transmission. Connection of various spaces is done to permit greater squares of coding where conceivable, confining not to surpass the biggest bolstered square. The Polar Encoder can be utilized for the encoding procedure. The polar transform \([5]\) of size \(N\) is defined to be,

\[
G_N = B_N \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} = B_N G_2^\otimes n
\]

Since \(B_2 = I_2\), one finds that

\[
G_2 = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}
\]

and this transform is a fundamental building block in Arikan’s construction of polar codes. The main idea is to construct a message vector \(u\) where the elements \(u_i\) with \(i \in A \subset \{1,2, \ldots, N\}\) carry information and the other elements \(u_j\) with \(j \in A^c\) contain values known at the transmitter and receiver (e.g., are fixed to 0’s). Then, the code-word \(x = uG_N\) is transmitted over the channel.

3.3 Channel Interleaver

Interleaving is accomplished at the yield of a polar encoder on encoded results. It tends to be utilized to control long mistake arrangements or burst blunders. The size of the square to interleave relies upon the quantity of coded bits per encoded square size. The interleaving is accomplished by means of a two-advance stage cycle. The neighboring coded pieces are planned to non-nearby subcarriers in the primary change and are characterized by the equation:

\[
m_k = (N_{cbp}/12) \mod (K, 12) + \text{floor}(K/12)
\]

Where, \(m_k\) = Index of coded bits following initial permutation

\(N_{cbp}\) = number of coded bits per symbols

\(K\) = Index of coded bits before initial permutation

3.4 IFFT

By multiplying the signal with a series of sinusoids, the Fourier breaks a signal in different frequency bins. This transforms the signal primarily from the time domain into the frequency domain. However, we still see IFFT as a method to transform the time domain to a frequency domain, and it can be transformed using formula,

\[
S_1^{(v)} = \frac{1}{\sqrt{N}} \sum_{m=1}^{N} x_m^{(v)} e^{j2\pi m v / N}
\]

In order to reduce inter-symbol conflict, the cyclic prefix was introduced in the time domain.

3.5 Channel

The channel is the medium for transmission of the signal. In wireless communication, air is the transmission medium. Various channels such as AWGN, Rayleigh, Rician, Nakagami or SUI are suitable for use in a WIMAX physical layer.

3.6 FFT

The cyclic prefix at the transmitter side is added to diminish ISI. Utilizing FFT or DFT calculation the got signal is changed into a recurrence area. As an OFDM image, it comprises of
information, pilots and a gatekeeper grouped Zero DC subcarrier. It extricates pilot transporters and information esteems here.

3.7 Demapper

This block is used to demodulate the signal waveform to digital data.

3.8 De-Interleaver

This block is used to undo the changes done by interleaver and recover the tangible data.

3.9 Polar Decoder

In this block, the redundancy added at the source side is eliminated. This redundancy is tested to see if errors occur.

3.10 De-Randomizer

De-randomizer does the transposed process of randomizer to reverse the effect of randomizer.

4. Simulation Results

In the simulation results, by using the polar coded WiMAX architecture, the PAPR performance and error rate performances are calculated over AWGN channels. In OFDM symbol, the number of sub carriers is presumed as N=1024 and 64, by using a 16-QAM modulation signal. Here, it consider a half rate polar code as k=n/2, as n=256 and 4096. The overall information rate is (k+n)/l in the proposed system. The shaping bits is considered as l=2 and 8 and the resulting number of OFDM symbol candidates as V= 4 and 64, correspondingly.

4.1 PAPR Performance

The complementary cumulative distribution function (CCDF) of the PAPR is considered by using the function as CCDF(x) = Pr (PAPR > x). The CCDF of PAPR exceeds a threshold. From the Fig. 2, Fig. 3 and Fig. 4, it can achieve a better PAPR performance by using the proposed polar coded WiMAX architecture with the different number of sub carriers. Here, the PAPR will be reduced and the gain will be increases. In the proposed structure, N=1024, v=4 and 64 respectively. Therefore it can offer a gain as 2.0 and 5dB in terms of PAPR performance with the probability as shows the PAPR performance as $10^{-2}$.

![Fig 2. General OFDM signal](image-url)
Fig 3. Using polar encoder

Fig 4. CCDF of PAPR at N=1024 (WiMAX)

4.2 Error Rate Performance

Fig. 5 shows the error rate execution of BER yield as for $E_s/N_0$ in the proposed PAPR decrease strategy, with $N = 64$ and 1024 where $E_s$ is a normal QAM Constellation image vitality and $N_0$ is a normal AWGN single-sided power phantom thickness. This decrease in proficiency can be because of
a higher code pace of polar codes (k+l)/n in examination with the customary one (k/n) of the proposed system. As opposed to PAPR results, this yield corruption is exceptionally low. Specifically, the BER yield debasement of the proposed PAPR decrease strategy with l = 8 and N = 64 is as little as 0.5 dB while the PAPR proficiency gain is more noteworthy than 5 dB.

![Fig 5. BER vs SNR at N=1024](image)

5. Conclusion

Here, for PAPR reduction Polar coded OFDM based WiMAX architecture was proposed. The proposed method was analyzed with various subcarriers, Various modulation techniques and compared with existing model in order to analyze the performance in reducing peak to power distortion without degrading the original signal as well as bit error rate performance. This suggested method shows better PAPR reduction and well as BER improvement, So that performance of High power amplifier cannot be degraded.

As a closing Statement, a significant addition in PAPR execution of the proposed framework is accomplished at the pace of expanded trouble at the transmitter side related with the FFT tasks, as regular SLM. We likewise note that the proposed method bargains a broad scope of compromise among transmitter complexity and PAPR execution by controlling the quantity of forming bits l.

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