Optimization of PAPR Reduction Technique for OFDM Signal Based Discrete Multiwavelet Critical-Sampling Transformin MC-CDMA using Selected Mapping with Phase Modification Method

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Abstract

Multi-carrier code-division multiple access (MC-CDMA) is an extensively known transmission technique for high speed data communication. In MC-CDMA, transmission is performed in parallel on various frequencies. This technique is widely sought after for the transmission of digital data via the media off adding channels. This paper showcases original contribution to the field of "peak-to-average power ratio (PAPR)" reduction effect by using "Multiwavelet Critical-Sampling Transform (DMWCST)" in the developmental "MC-CDMA systems". In this study, primarily oriented towards the selected mapping techniques and phase modification was used. As well showcase how selected mapping with phase modification can be applied to mitigate PAPR since they are signal distortion less and their complexity is lesser compared to other techniques.

Key words: MC-CDMA, OFDM, PAPR, CCDF, DMWCST.

تحسين تقنية تقليل نسبة القدرة العظمى الى القدرة المعدلة لاشارة مقسم التردد العامودي المبني على التحويلالمنفصللمتعددالمويجاتالعينةالحرجة في تقسيم الرموز لعدة حوامل بتعدد الدخولباستخدام طرق اختيارتقنياتالتضمين و تحسين الطور

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الخلاصة

تقسيم الرموز لعدة حوامل بتعدد الدخول (MC-CDMA) هواسلوب معروف على نطاق واسع لنقل البيانات بسرعة عالية. فى MC-CDMA يتم الارسال على التوازى فى مختلف الترددات. هذا الاسلوب على نطاق واسع لنقل البيانات الرقمية عن طريق وسائط نقل وقنوات تلاشي ضعيفة. هذا العملي عرض اسهامه الاصلى فى مجال تقليل نسبة القدرة العظمى الى القدرة المعدلة لاشارة مقسم التردد العامود بياستخدام نظام التحويل المنفص للمتعدد المويجات العينة الحرجة في تطوير نظام-MC CDMA .فىهذا العمل, فى المقام الاول الاتجاه نحو مرحلة اختيار تقنيات التضمين و تحسين الطور وكيفية تطبيقه لتخفيف PAPRلا نتشويه الاشارة اقل و درجة التعقيد اقل مقارنة بتقنيات اخرى.

Introduction

Mobile radio communication schemes are required to render high-character multimedia services to mobile users. To cater for same, modern mobile systems are required to strengthen high capacity and changeable bit rate transmission with bandwidth efficiency to safeguard the restricted spectrum resource. Generally, MC-CDMA accumulated a considerable measure of consideration towards future creation of wireless communication. MC-CDMA is a cross breed gathering of two access techniques, “frequency division multiplexing (OFDM)” and “Code Division Multiple Access (CDMA)” which consider advantage of two strategies. Recently, CDMA strategy has been considering as a hopeful that requirements quick and capable information exchange to bolster interactive media administrations, video conferencing and promote applications[1-3]. MC-CDMA and OFDM frameworks are generally utilized as a part of the current third and fourth generation wireless networks. They are excessively perceived candidates for the future era systems for broadband and individual correspondences. In that capacity,“Discrete Multiwavelet Transform (DMWT)” is intended to meet the previously stated need. So this anticipate shows DMWT subordinate orthogonal modulator. But, “Discrete Wavelet Transform (DWT)” have the great properties however it doesn't satisfy the future needs. By actualizing DMWT, it can accomplish sound ghastly proficiency and increases great “bit error rate (BER)” when contrasted with “Fast Fourier Transform (FFT)” and DWT[4]. MC-CDMA system is extensively used for “Long Term Evaluation (LTE)”,“Worldwide Interoperability for Microwave Access (WiMAX)”, and Digital TV transmission [5].It MC-CDMA schemes have inbuilt issue of a high PAPR and also the reason for serious performance degradation in the transmitted signal.One of the key downsides of an OFDM plan is that it has a high crest factor. Brought about by the nonlinearity of a powerful enhancer “high power amplifier (HPA)”, the high crest factor component acquires on sign twisting the nonlinear HPA. These further results in the debasement of “bit error rate (BER)”.Numeroustopic[6-16] has been considered to mitigate the crest factor of the OFDM signals. The alignment for the crest factor reduction can be categorized into two types. First, there are deterministic approaches that keep the limit forthe crest factor of the OFDM signals under a limit level. Clipping and block coding have a place with this write. The second sort is reliant on probabilistic technique. These methodologies factually propel the run of the mill of the crest factor appropriation of the OFDM signals without sign bending. “Selected mapping (SLM)” and “partial transmit sequence (PTS)”[17-20]form part of this type. In the SLM with OFDM system, an arrangement of comparable symbol sequences is delivered from a given information symbol sequence by having the capacity to duplicate with the stage successions. At that point, the one with the crest factor variable in the set is decided for transmission. It is recognized from the reproduction results in various writing[21, 22] that the randomly produced phase sequence set outperforms any other applicants in SLM OFDM scheme. Theresearch issystematized as follows. Section two briefly showcases the proposed modified “MC-CDMA transceiver”. Simulation results are rendered in Section three. At last, conclusions are drawn in Section four.

Proposed of Modified MC-CDMA Transceiver

Block diagram of Modified MC-CDMA Transceiver as shown Figure 1.In selective mapping, parallel data symbols are multiplied by the phase sequences before the procedure computation of “Invers Multiwavelet Critical-Sampling Transform (IDMWCST)” in [23]. Thereafter, symbol sequence with the lesser PAPR is picked upand transmitted. The multiwavelet two scale equations mirrors those for scalar wavelets [24]:

$$\Phi(t) = \sqrt{2}\sum_{k=-\infty}^{\infty} \mathrm{H_k}\,\Phi(2\mathrm{t}-\mathrm{k}), \quad (1)$$

$$\psi(t) = \sqrt{2}\sum_{k=-\infty}^{\infty} \mathrm{G_k}\,\Phi(2\mathrm{t}-\mathrm{k}) \quad (2)$$

Albiet,$H_k$andG_k, and are *matrix* filters (i.e.,$H_k$and G_k *are* $n \times n$ matrices in place of scalars).
In order to pull back the source data at the receiver, information is needed forchannel exemplification of the block of source data to be transmitted. Alongside, this information is transmitted apart, and is called out as side information.
Figure 1 showcases the functional block diagram of MC-CDMA scheme with phase modification. The complex-valued data symbol$S(k)$ is multiplied alongwith user specific spreading code $C^{(k)} = \left(C_0^{(k)}, C_0^{(k)}, \dots C_{V-1}^{(k)}\right)^T$ of spreading factor *V*. The complex-valued sequence sought after spreading is rendered in vector notations as,$n(k) = S(k)C(k) = \left(N_0^{(k)}, N_0^{(k)}, \dots N_{V-1}^{(k)}\right)^T$.A multi-carrier spread spectrum signal is considered after modulating the components$N_v^{(k)}, v = 0, \dots, V-1$, in parallel onto *V* sub-carriers. Let us consider for now that *K* users are supremely transmitting data. The spread data symbols of *K* users are summed, and then input to the IDMWCST of size *Z=1xV*. The signal for MC-CDMA symbol, $0 \le t \le T$is showcased as

$$m(t) = \frac{1}{\sqrt{2D_r}}\sum_{d=0}^{2^D-1}\sum_{t=1}^{T}\sum_{k=1}^{K} S(k)\,C_v(k)\phi_{d,t} \qquad 0 \le t \le T \qquad (3)$$

Hereby,*m*[*n*] relies on the selected phase-shifted signal. The optimization problem which we are intending to resolve is to minimize the PAPR. The PAPR is used as the objective phase modification of the optimization problem; so;where: *T* is the data duration, the PAPR of the transmitted signal in (1) can be written as:

$$PAPR = \frac{max|m(t)|^2}{E[|m(t)|^2]} \quad (4)$$

Where $max|m(t)|^2$signifies the peak power and $E[|m(t)|^2]$ means the average power. Further, E [.] denotes expectation and complementary cumulative distribution function for MC-CDMA signal can be written as “Complementary Cumulative Distribution Function (CCDF)” = probability (PAPR> P0), where P0 is the Threshold [12]. PAPR of MC-CDMA signal is mathematically definite as

$$PAPR = 10log_{10}\frac{max|m(t)|^2}{\frac{1}{T}\int_0^T |m(t)|^2\,dt} \quad dB \qquad (5)$$

It further guides the above equation by decreasing the numerator $max|m(t)|^2$ or increasing the denominator $E|m(t)|^2$or both.If the number of subcarriers becomes large, the PAPR of transmitted signal becomes large and as such the signal is distorted by the nonlinear amplifer. To decrease the nonlinear distortion of nonlinear amplifer, we need to decrease the PAPR of transmit signal. When $0 \leq \Theta_i \leq 2\pi$, the resultant baseband transmission is stated as:

$S^{(n)}[p] = m(t)e^{j\Theta_i}(6)$

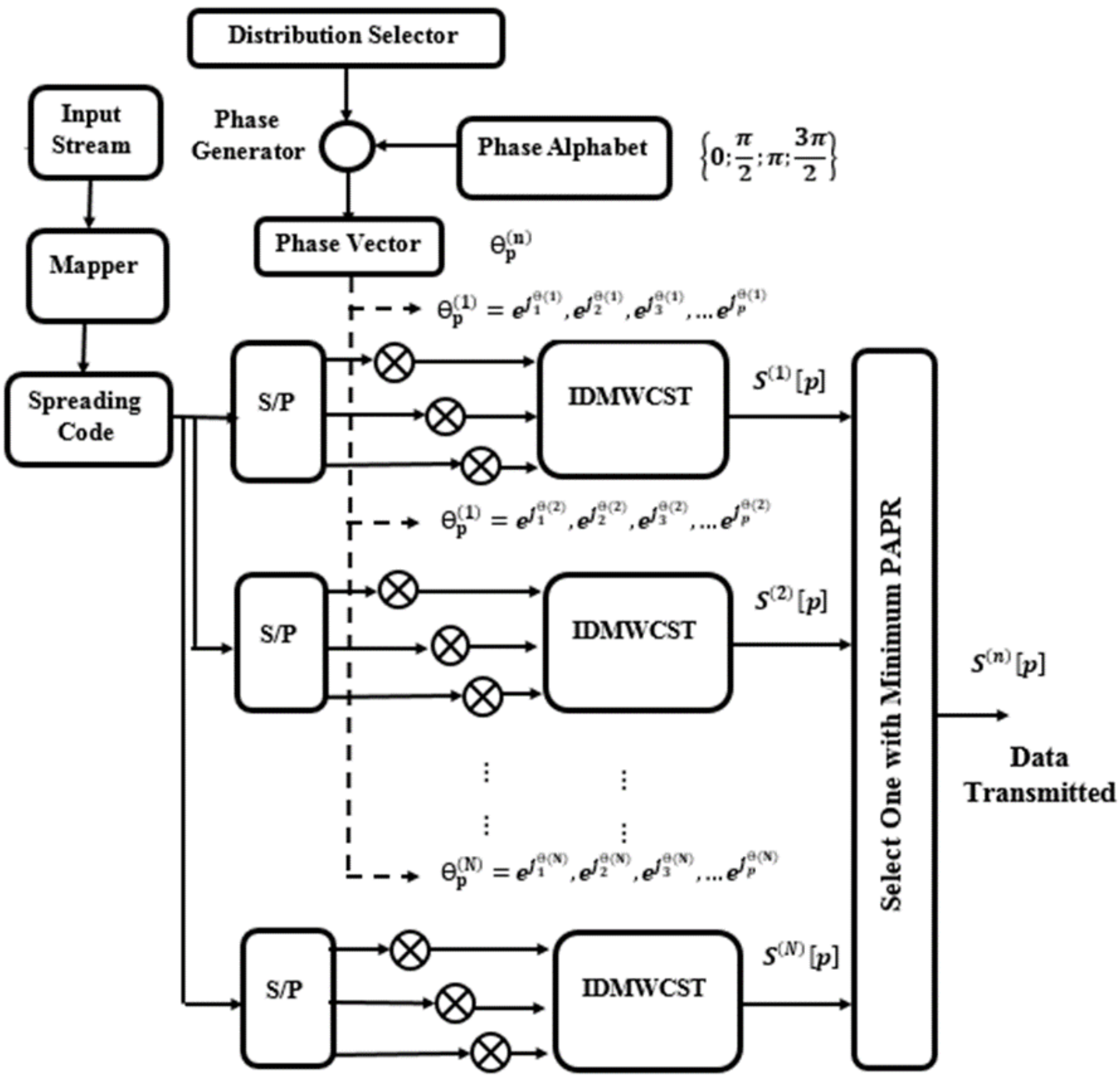

Figure 1*: Block diagram of MC-CDMA System Based OFDM Discrete "Multiwavelet Critical-Sampling Transform" using "Selected Mapping with Phase Modification"*

Simulation Results

In this section, we reconfirm results of the studies and assess the performance of MC-CDMA dependentDMWCST signals with the PAPR reduction method. The examination are carried out using "MATLAB R2015a" simulations and the performance metric of select is the "Complementary Cumulative Distribution Function (CCDF)". In "Orthogonal Frequency Division Multiplexing (OFDM)" the PAPR is commonly calculated per symbol. This is not possible in DMWCSTdue toDMWCST symbols overlap in the time-domain while the PAPR has to be computed per frame. The DMWCST system is recognized using a filter bank structure with many levels of decomposition. The modulation structure used is "4-QAM". The phase alphabet is taken to be $\phi \in (0, \pi/2, \pi, 3\pi/2)$ which is randomly selectedthoughproducing the phase vector.

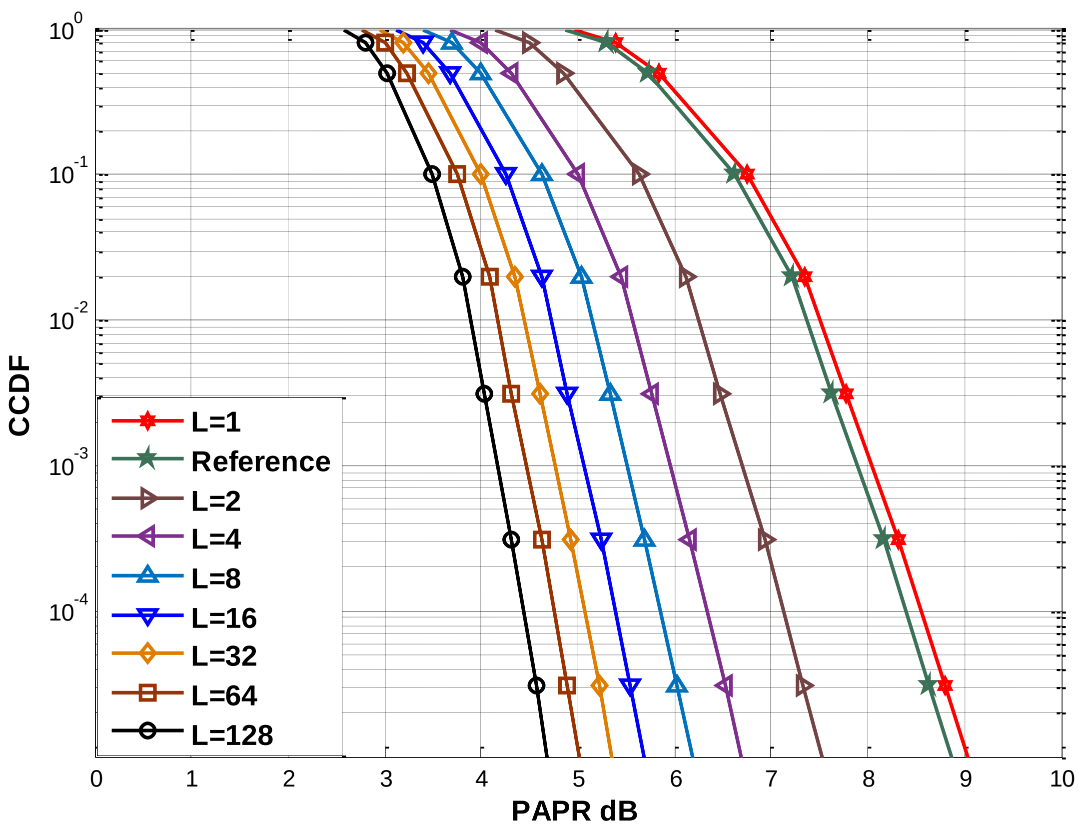

Figure 2: *CCDF of the PAPR of the MC-CDMA System based DMWCST signals for different values of L. A reference curve with no PAPR reduction is also plotted.*

To suitably scrutinize the enhancements due to the PAPR reduction method, a reference PAPR-CCDF curve achieved for DMWCST for the case without PAPR reduction (i.e. no phase modification) will too be rendered. Figure 2 showcases the CCDF curves for the difference of PAPR under the PAPR reduction method for different number of replications, *L*. It is vivid from the plots that the enhancements are crucial and bring in up to 3.5dB reduction in PAPR in comparison to the case when no PAPR reduction method is used.

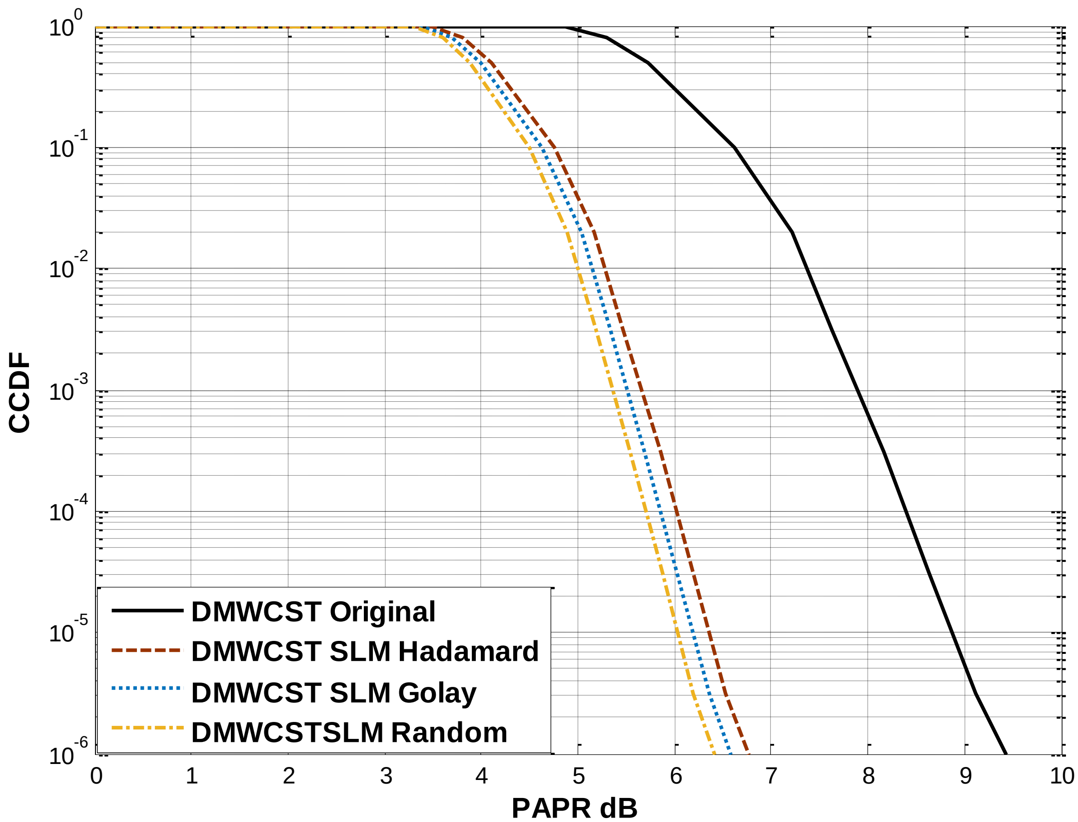

Figure 3: *Complementary cumulative distribution function (CCDF) of the PAPR of MC-CDMA System based DMWCST signals for different distributions of the phase sequences.*

Figure 3 displays the respective plots and it can be inferred from the figures that all the distributions result insignificant improvements. Also, there are no notable differences in their performances. These results are crucial because the imperceptible difference in the performances when using pseudo-random and random sequences. This also means that the former can be used in place of the later. Thus the receiver end only needs to know the key used to generate the pseudo-random phase sequences used at the transmitter (and not the entirephase sequence). This guides the way for a notable mitigation in the transfer of side information.

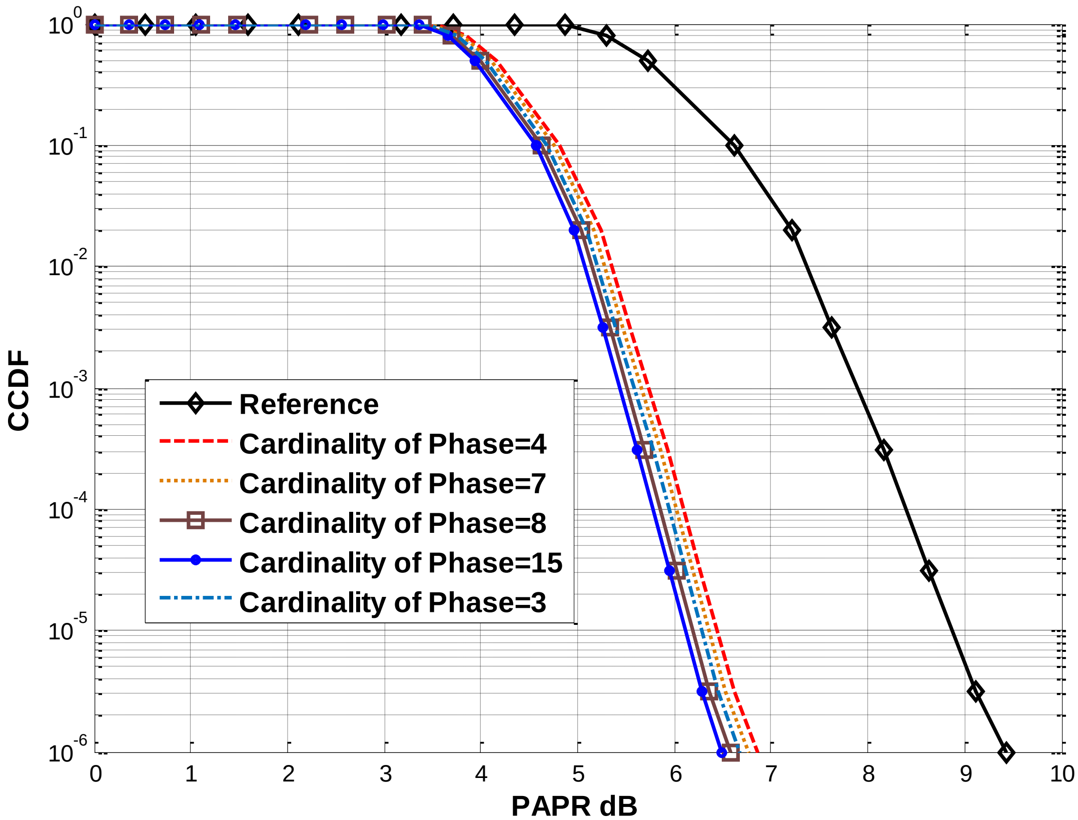

Figure 4: *CCDF of the PAPR of MC-CDMA System based DMWCST signals using the PAPR reduction method for different phase sequences.*

We presently scrutinize the impact of the phase alphabet on the PAPR reduction technique. The results are displayed in Figure 4where a range of cardinalities for the phases are referred back. The results showcased based on the select of the phase alphabet does not affect the performance of the PAPR reduction method.

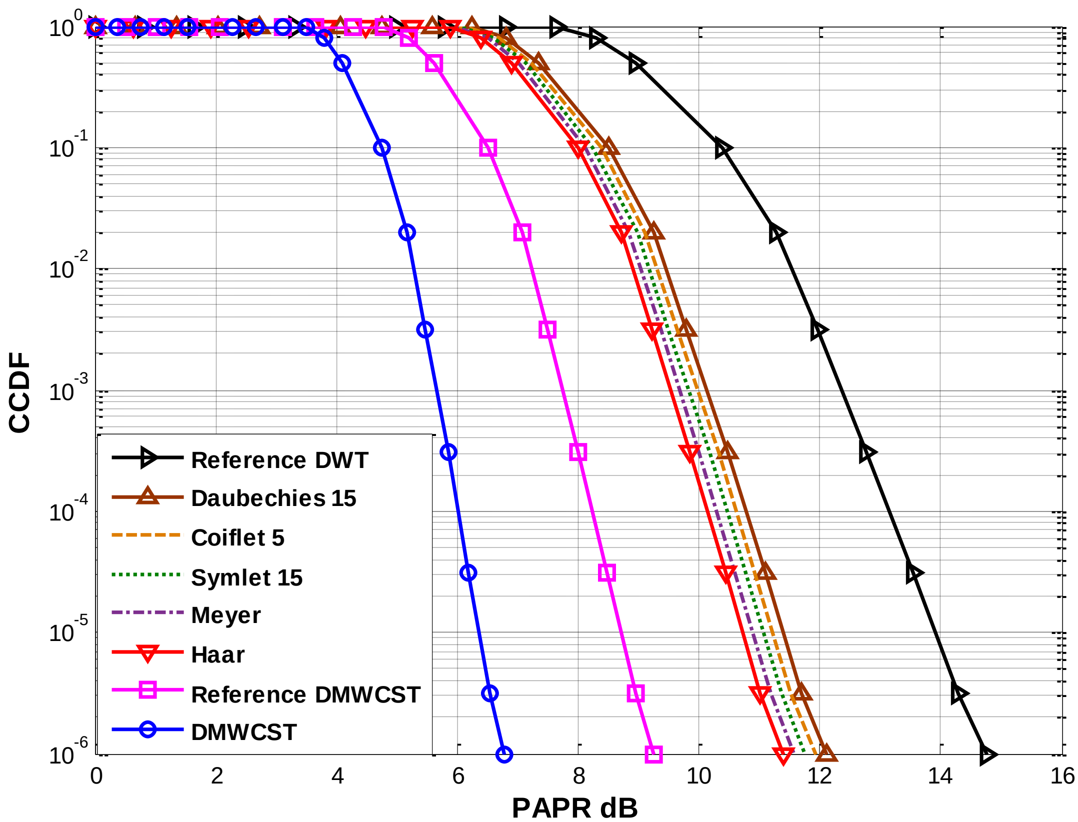

Figure 5: *CCDF comparison of the PAPR for MC-CDMA System based DMWCST signals and several DWT family.*

In Figure 5 where a comparison between DWT family and DMWCST for the phases are referred back, we can infer that all the wavelets follow a similar CCDF pattern for their PAPR performances. Also show the PAPR performance curves for various wavelet families and various filter lengths, respectively. Simulations analyzed also verified that suggested design using DMWCST achieves much lower PAPR and enhanced performance over other DWT family.

Conclusion

In this work, we suggested a technique to mitigate the PAPR in the progressive"MC-CDMA" System based DMWCST signals. The method revealed the postulate that by modifying the phase of the DMWCST sub-carriers one can amend the PAPR of the transmitted signal. By randomly changing the phases of the sub-carriers that modulate the information, one can get different DMWCST frames with different PAPRs. In addition, by transmitting the DMWCST frame with least PAPR than other DWT family, the probability of the DMWCST system slipping into non-linear region is significantly lowered

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