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ANALYSIS ON APPLICATION OF BROADBAND PULSE SHAPING FOR THE REDUCTION OF WEIGHTED OFDM BASED PEAK-TO-AVERAGE POWER RATIO

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ABSTRACT

OFDM is an appealing modulation and multiple access technology for channels having a non-flat frequency response because it eliminates the need for complicated equalisers. Orthogonal Frequency Division Multiplexing In terms of bandwidth efficiency, resistance against multipath fading, and cost-effective implementation, it can deliver excellent results. There are a few downsides to this method, including its high peak-to-average power ratio (PAPR). Because of its adaptability and scalability, OFDM is a viable option for CR systems. A non-contiguous OFDM (NCOFDM) technique is proposed in this dissertation, where the implementation achieves high data rates of noncontiguous subcarriers while avoiding any interference. DFT precoding and Gaussian minimum shift keying (GMSK) pulse shaping are used in an unique modulation strategy proposed in this research to lower the PAPR of OFDM-based VLC systems. In addition, to deal with the increased complexity of the DFT precoding system, the notion of group precoding is added. As compared to DFT precoded O-OFDM and O-OFDM counterparts, the findings reveal that different variants of the proposed system provide superior PAPR, symbol error rate (SER), and power-saving performance Furthermore, the proposed system's PAPR analysis, computational complexity, and spectral efficiency have been studied and reported in this research.

1. INTRODUCTION

There is an increasing demand for wireless systems that are both reliable and efficient in terms of spectrum efficiency because of the rapid expansion of digital communications. There has been an increase in orthogonal frequency division multiplexing in wireless communications (OFDM). High data rates can be delivered even when the radio channel is deteriorated thanks to OFDM's ability to use several channels. Since the introduction of OFDM systems in recent years, both fixed and mobile transmission have reaped the benefits. Asymmetric Digital Subscriber Line (ADSL) modems and digital audio and video broadcasting use OFDM. It is possible to transmit up to 54 Mbps using OFDM in the physical layer implementation. The usage of OFDM in wireless asynchronous transfer mode (WATM) and 4G transmission systems is also being researched for the future.

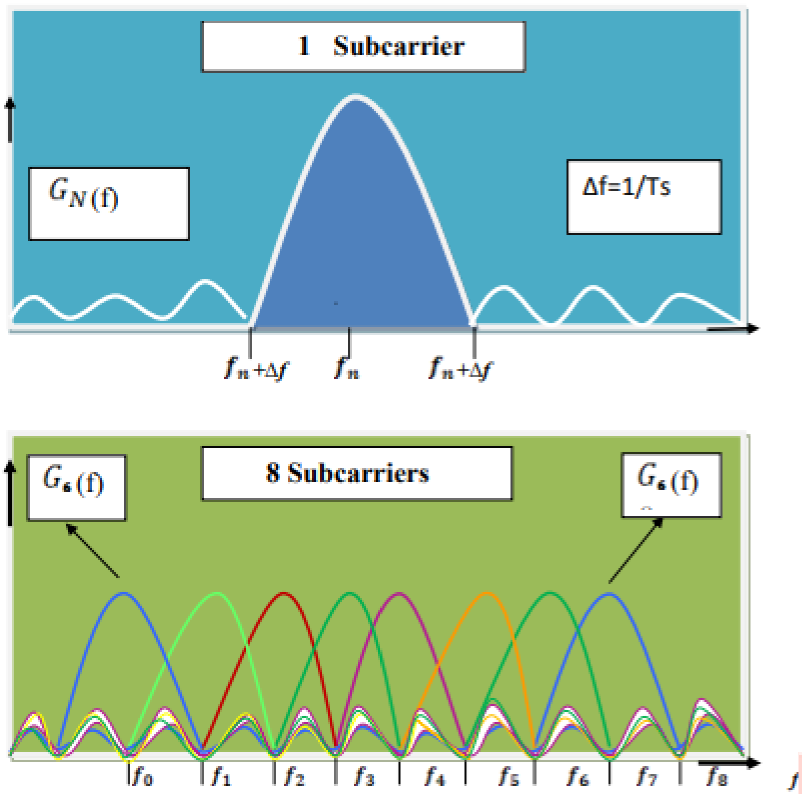

Figure 1. 1-OFDM subcarriers in frequency domain.

Each subcarrier in an OFDM system carries a low-rate data stream, which is modulated by several carriers. As depicted in Figure 1, the subcarriers are spaced properly and have a pass-band filter shape that satisfies orthogonality. To achieve the Cognitive Radio (CR) concept, OFDM provides a dependable, scalable, and adaptable wireless communication method. It is possible to entirely eliminate inter-symbol interference (ISI) by utilising a guard band in each OFDM symbol. To avoid inter-carrier interference in OFDM, the guard band is cyclically stretched (ICI). OFDM systems have the advantage of being able to withstand channel fading in wireless environments. Increasing the number of subcarriers reduces frequency selective fading. Because the coherence bandwidth is greater than the subcarrier spacing, an equalised channel will have no effect on the individual subcarriers.

Since OFDM's high spectral efficiency and robustness to multipath fading channels make it ideal for 4th-generation (4G) wireless communication standards like LTE-A, WiMAX, asymmetric digital subscriber line (ADSL), digital audio broadcasting (DAB), and digital video broadcasting (DVB), it's been widely used in these standards. Recently, it has been predicted that the next generation of communication standards, 5G, will be able to accommodate new applications with more diverse requirements and specifications. Up to 100,000 devices and sensor modules can be connected to a single 5G network, making it ideal for the Internet of Things (IoT).

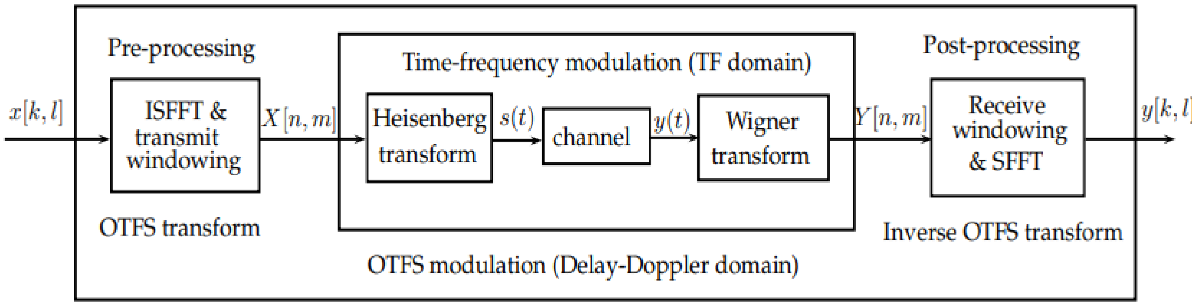

Fig. 2: OTFS modulation scheme.

Figure 1 depicts an OTFS modulation block diagram built on top of a multicarrier modulation system in general. The weighted OFDM system employed the Gaussian function, sine function, and other functions as weighted functions. Using the Gaussian weighted OFDM system, the PAPR of the system is much reduced when the noise is not there. As stated in the concluding paragraph, however, the noise was not also taken into account when determining the performance of the bit error rate. The BER performance of the weighted OFDM system with Gaussian weight is even worse if the additive Gaussian noise is taken into account. BER performance can be improved by using a modified weighted OFDM system with a weighted OFDM system with a weighted OFDM system, and we offer the mathematical justification for the weighted OFDM system derived from the circular convolution system.

2. LITERATURE REVIEW

To minimise peak-to-average power ratio (PAPR) in OFDM systems, existing approaches do not work because OFDM and OFDM systems have different signal structures. The IBPTS technique reduces the peak value probability of the processed FBMC/OQAM signal, which is the core principle of this joint optimization scheme. The IBPTS-ICF combined optimization approach, supplemented by convex optimization knowledge, may efficiently eliminate signal distortion. As Linlong Wu et al. have demonstrated, the proposed technique has a fantastic PAPR reduction performance.

With the use of OFDM and MIMO, high data rates can be achieved and great dependability can be maintained in wireless communication. Since it's robust against narrowband interference and can lessen multipath fading, it has a number of advantages that can simplify receivers. The SQNR and power amplifier efficiency of MIMO-OFDM are lowered due to the high power amplifier gain-to-noise ratio (PAPR). Our research is focused on iterative clipping, filtering, and partial transmit sequence (PTS), because of its superior performance. Ashna Kakkar et al. show that when the two approaches are combined, the PAPR value is reduced, but the power spectral density is also smoothed.

To improve the performance of next-generation WLAN systems, orthogonal frequency division multiplexing (OFDM) and MIMO signal processing are being considered. In addition, MIMO-OFDM has the potential problem of sending signals with an excessively high peak-to-average power ratio, as is the case with OFDM (PAPR). Partial transmit sequence (PTS) in OFDM or MIMO-OFDM reduces PAPR in an appealing way. Unfortunately, this will require a lot of calculation. This study provides a number of low-complexity PTS strategies for decreasing PAPR in MIMO-OFDM systems using the Firefly algorithm (FA) and space-frequency block codes (SFBC).

Simulation results show that the PTS-based FA can reduce computational complexity and provide better PAPR reduction than traditional PTS, according to Ho-Lung Hung et al.

An increasing number of researchers are studying the filter bank multicarrier (FBMC/OQAM) as a potential fifth-generation air interface. Data block partial transmit sequence (PTS) and tone reservation in this study help minimise the PAPR in FBMC/OQAM signals by decreasing the peak-to-average power ratio (PAPR) (TR). An essential consideration is how many data blocks are in each segment in a hybrid PTSTR. For each transmission segment, we select the most efficient data block to send at the beginning to minimise signal power consumption. Then, the peaks of the segment FBMC/OQAM signals are reduced using peak reduction tones. In FBMC/OQAM systems, the suggested hybrid PTS-TR scheme reduces PAPR better than standard PTS and TR schemes, according to simulations and analyses. As a result, we suggest a new multi-hybrid (M-hybrid) data block hybrid PTS-TR technique, which exploits adjacent multi overlapping data blocks. The M-hybrid scheme can outperform the hybrid PTSTR method et al. by roughly 0.2 dB in terms of PAPR performance. The name of the author is H. Wang.

High-speed wireless communication technologies frequently use orthogonal frequency division multiplexing (OFDM). It has long been recognised that OFDM systems suffer from high peak-to-average power ratios (PAPR). The OFDM system's high PAPR has caused a variety of issues, including signal distortion, energy spillover to the next channel, and a progressive decrease in system performance. It will be discussed in this paper how to manipulate codewords by means of a circulant shift. The main idea of the suggested technique is to generate scrambled data sequences, like the usual selective mapping (SLM) technique. As demonstrated by the simulations, the proposed method outperformed both the original OFDM signals and traditional SLM by 19.5% while differing by 1.11 dB. In addition, the proposed method gave a lower computational complexity, with the number of IFFT blocks reduced by around 57% compared to traditional proposed by SLM et al. E. Abdullah

3. OFDM PULSE SHAPE DESIGN AND PROPOSED METHODS

Multi-service applications with a wide range of requirements will be able to coexist on future mobile communication networks. It is expected that the PHY settings, including waveform design, will be tailored to each service's specific needs. URLLC, for example, has minimal latency requirements and benefits from a relatively brief pulse. It is possible to build lengthy pulses in the narrowband internet of things (NB-IOT) service. In order for MTC to be effective, pulse designs that are resistant to asynchronicity and Doppler spread may be required. Pulse shape design methodologies are discussed in this section, along with their features and applications.

3.1 Pulse shape categorization

By structuring the transmit and receive pulses in an OFDM system, the ISI and ICI can be computed γ(t). Pulse shape categorization is used in this paper based on the correlation property:

- *An orthogonal pulse design uses matching filtering and a perfect reconstruction condition to shape the pulses.*
- *When the perfect reconstruction condition is met and mismatched filtering is used, a bi-orthogonal pulse design is utilised.*
- *Non-orthogonal pulse design is a pulse shaping approach in which the perfect reconstruction conditions are not met.*

Design criteria

Pulse-shaped OFDM systems are designed to meet a variety of needs, depending on the individual criteria. The pulse shape design has to meet a number of common requirements.

3.2 Length constraint

OFDM pulse shapes are designed with a length constraint in mind. eMBB and URLLC applications often necessitate very fast processing delay and precise timing for framed transmission, therefore pulse lengths as short as one OFDM symbol duration (i.e., K≃1) are a good fit for this scenario. Latency limits may be eased in other cases, such as in the MTC or NB-IOT, allowing pulse lengths of multiple symbols (K≥2) provided they clearly benefit the related service.

3.3 SIR/SINR optimization

Transmission of signals in practical channels is vital in wireless communication systems. The preceding criteria might therefore be partially loosened to maximise the design freedom, provided that the link performance with pulse shaping is tuned in relation to certain interesting dispersive channels.

In dispersive channels, transceiver pulses are selected to optimise SIR/SINR, and this is a frequent criterion. These pulse forms may not meet ideal reconstruction conditions, but they are more ISI/ICI resilient in dispersive channels than orthogonal or bi-orthogonal designs. Discrete and continuous channel models are discussed in detail in the following.

3.4 FBMC/OQAM Structure

Figure 2 shows the structure of the FBMC/OQAM transmitter. The FBMC/OQAM signal structure is varied from that of the OFDM by replacing the CP with a pulse-shaping filter bank and OQAM modulation. **Figure 3** shows the FBMC signal structure; it mainly consists of M overlapped data blocks. Each symbol contains N sub-carriers, and the n^{th} sub-carrier on the m^{th} block carries the QAM-modulated data symbols, xn,m. The signal in the time domain is expressed as follows:

$$s(t) = \sum_{n=0}^{N-1}\sum_{m=0}^{M-1} x_{n,m} h(t)_{n,m},\ 0 \le t \le \left(M + K - \frac{1}{2}\right)T$$

$$s(t) = \sum_{n=0}^{N-1}\sum_{m=0}^{M-1} \left\{c_{n,m} h(t - mT) + j d_{n,m} h\left(t - mT - \frac{T}{2}\right)\right\} e^{j\varphi_{n,m}}$$

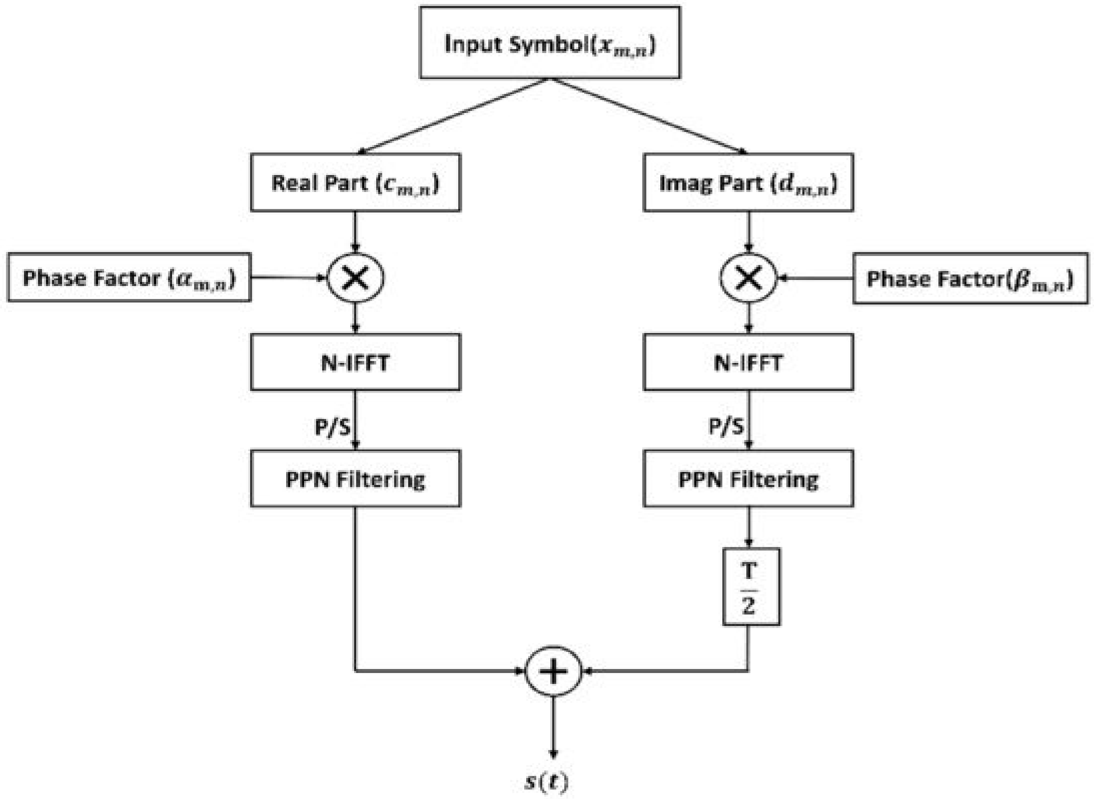

Figure 3. Transmitter structure of FBMC/OQAM (filter bank multicarrier with offset quadrature amplitude modulation).

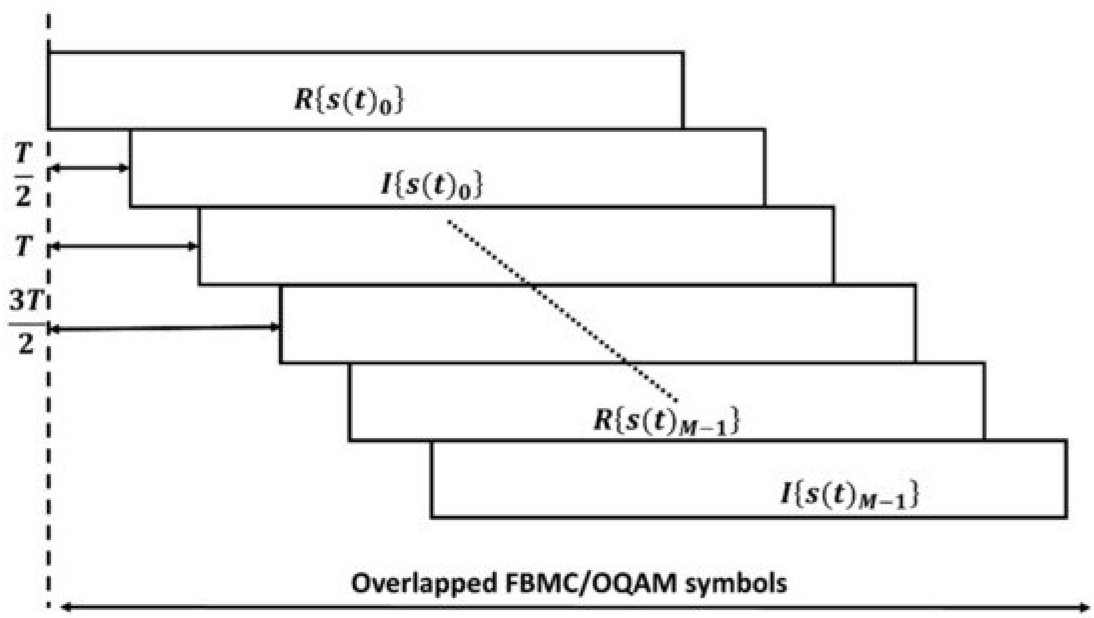

Figure 4. Structure of FBMC/OQAM (filter bank multicarrier with offset quadrature amplitude modulation) signal.

The FBMC/OQAM system consists of synthesis and analysis filter banks placed at the transmitter and receiver sides, respectively. The synthesis and analysis filters complement each other and satisfy the Nyquist criterion. The PHYDYAS project introduced two different approaches of implementing the filter bank, which are the frequency spreading (FS) and the polyphase network (PPN). FS-FBMC requires KT point IFFT/FFT because the data are spread in frequency while PPN-FBMC requires only N point IFFT/FFT. For our study, we chose the PPN filter structure as it requires less computational complexity than FS-FBMC. A filter bank based on PPN structure is constructed from N filters by shifting the prototype filter's response by multiples of 1/N in the frequency domain. All the filters in the network are linear phased.

4. RESULTS AND DISCUSSION

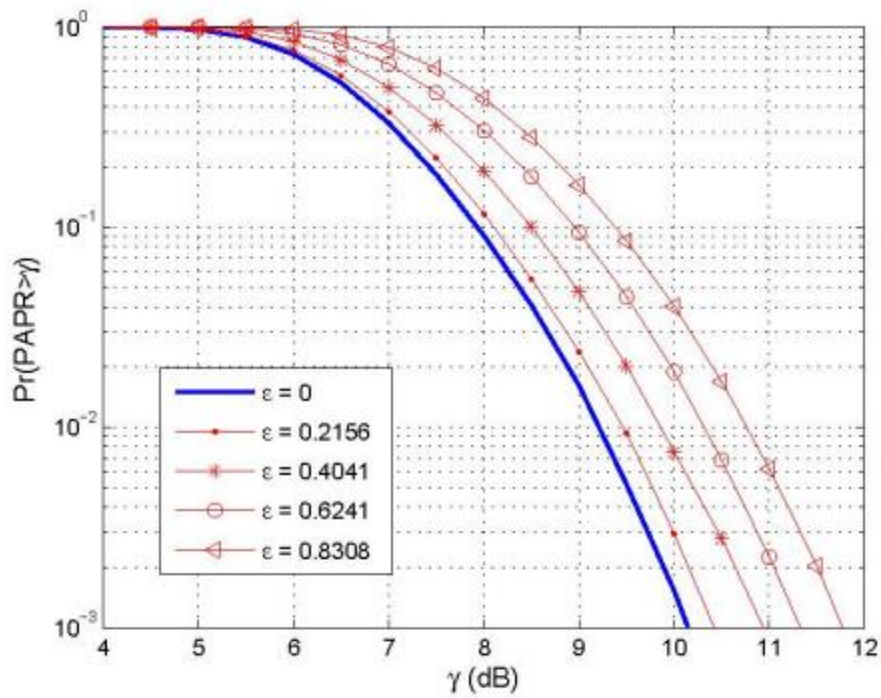

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Fig. 5. Impact of c on the CCDF (M = 64).

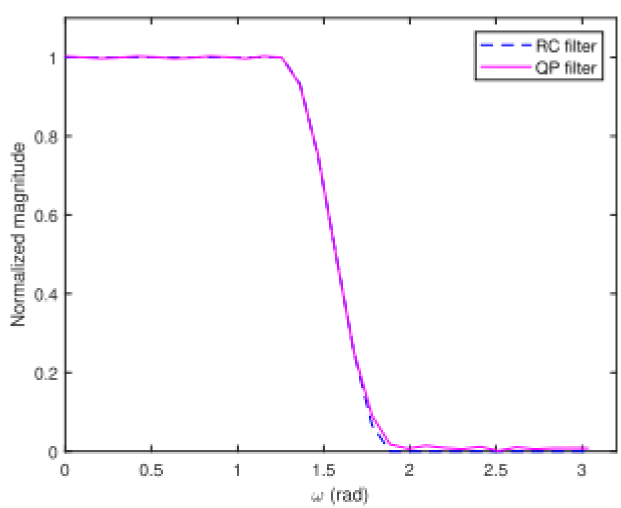

FIGURE 6. Frequency response of designed quadratic programming (QP) pulse shaping filter, compared with the desired filter, raised cosine (RC) filter.

The design of the FIR filter does not require more than R = 28 taps in the FIR filter. Tolerance σp = 0.001 permits a design to accurately approximate the required filter frequency response without imposing an excessive constraint. It's important that the GFDM system's discretization value L correspond to the filter length. There is a summary of filter design parameters. According to the frequency response shown in Fig. 6, the developed filter closely approximates the frequency response of an RC filter.

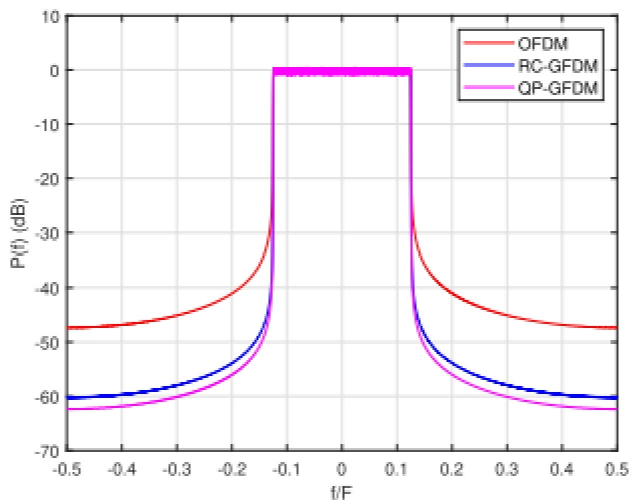

FIGURE 7. OOB radiation of QP-GFDM, compared with RC-GFDM and OFDM.

It is shown in Fig. 7 that when using the developed pulse shaping filter, the OOB radiation is reduced by three decibels and is more than 10 decibels lower than when using an ideal RC filter. There are a number of pulse shaping filters that may be used to get the required filter frequency response, Pd (ω), in literature. The performance of the developed filter should next be compared to the performance of the required filter in the GFDM system.

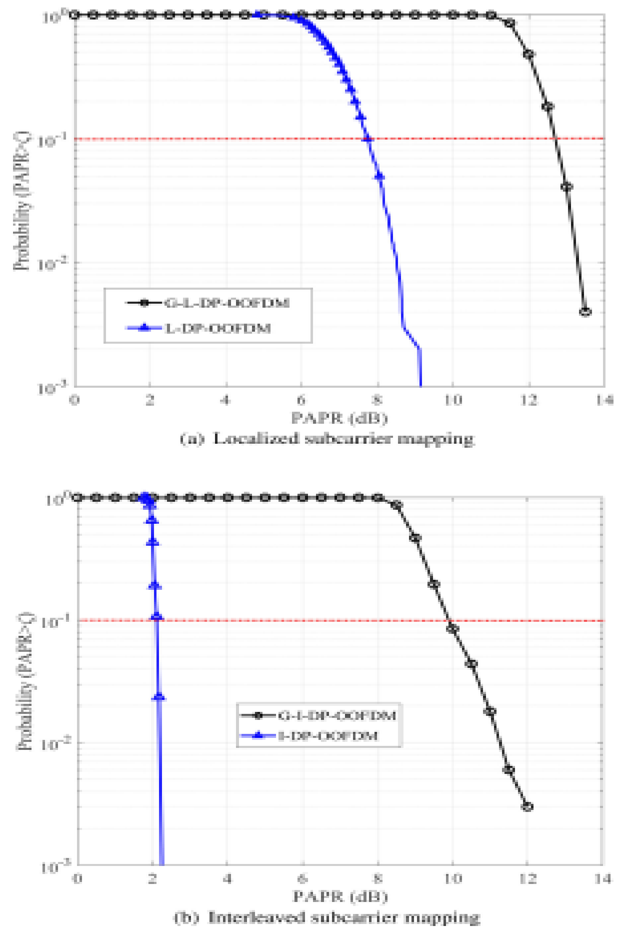

FIGURE 8. Effect of grouped DFT precoding on CCDF distribution of PAPR.

Grouped DFT precoding has an influence on the proposed DP-OOFDM in terms of PAPR CCDF as shown in Fig 8. Grouped setups have a higher PAPR than ungrouped configurations, as can be seen in the graph.

CONCLUSION

On the basis of complexity, spectrum efficiency, PAPR, power savings, and signal-to-noise ratio (SER), we have assessed the DP-OOFDM scheme in this study against traditional DFT-precoded OOFDM and ACO-OFDM. The proposed method introduces a new approach to reducing the PAPR by combining DFT spreading with a modified PTS method. After conducting several simulations, the results showed a significant reduction in the PAPR with an average of 32.8%, without worsening the BER performance. STBC MIMO-OFDM - 5G has a cooperative and alternate partial transmit sequence (PTS) that takes advantage of both real and imaginary part joint optimization of the PAPR. A high PAPR is specified for transmission between the two antennas. In terms of simulation results and processing complexity, the proposed technique performs admirably.

REFERENCES

[1] Linlong Wu, Prabhu Babu, and Daniel P. Palomar, "Transmit Waveform/Receive Filter Design for MIMO Radar With Multiple Waveform Constraints", IEEE Transactions on Signal Processing, Vol. 66, No. 6, March 15, 2018.

[2] Ashna Kakkar, Sai Nitesh Garsha, Ojasvi Jain and Kritika, "Improvisation in BER and PAPR by using hybrid reduction techniques in MIMO-OFDM employing channel estimation techniques", 7th International Advance Computing Conference, IEEE 2017.

[3] Ho-Lung Hung, Yung-Fa Huang, Ching-Chuan and Rung-Ching Chen, "Performance of PTS-Based Firefly Algorithm Scheme for PAPR

Reduction in SFBC MIMO-OFDM Communication Systems”, International Symposium on Computer, Consumer and Control, IEEE 2016.

[4] H. Wang, X. Wang, L. Xu, and W. Du, “Hybrid PAPR reduction scheme for FBMC/OQAM systems based on multi data block PTS and TR methods”, IEEE Access, vol. 4, pp. 4761_4768, 2016.

[5] E. Abdullah, A. Idris, A. Saparon, "Minimizing High PAPR in OFDM System Using Circulant Shift Code word", J. Technology, vol. 78, no. 2, pp. 135-140, 2016.

[6] Manishaben Jaiswal, "DATA MINING TECHNIQUES AND KNOWLEDGE DISCOVERY DATABASE", IJRAR - International Journal of Research and Analytical Reviews (IJRAR), E-ISSN 2348-1269, P- ISSN 2349-5138, Volume.2, Issue 1, Page No pp.248-259, February 2015, Available at : http://www.ijrar.org/IJRAR19D2907.pdf

[7] P. Siohan, C. Siclet, and N. Lacaille, "Analysis and Design of OFDM/OQAM Systems Based on Filterbank Theory," IEEE Trans. on signalprocessing, vol. 50, no. 5, pp. 1170 - 1183, May 2002.

[8] 3GPP TSG-RAN WG1, "TR25.892 Feasibility Study of OFDM for UTRAN Enhancement," V]. 1. 0, 2004.

[9] L. Hanzo, M. Miinster, B. J. Choi, and T. Keller, OFDM and MC-CDMA for broadband Multi-Users communications, WLANs and Broadcasting, IEEE press. Wiley Series, 2003.

[10] S. Ben Slimane, "Peak to Average Power Ratio Reduction of OFDM Signals using Pulse Shape," in Globecom '00, November 2000, pp. 1412- 1416.

[11] T. Giannopoulos and V. Paliouras, "An Efficient Architecture for Peakto-Average Power Ratio Reduction in OFDM Systems in the Presence of Pulse-Shaping Filtering," in ISCAS '04, May 2004, pp. 985 - 988.

[12] R. Bauml, R. Fischer, and J. Huber, "Reducing the Peak-to-Average Power Ratio of Multicarrier Modulation by Selected Mapping," Electronics Letters, vol. 32, no. 22, pp. 2056-2057, October 1996.

[13] R. van Nee and A. de Wild, "Reducing the Peak-to-Average Power Ratio of OFDM," in VTC, May 1998, pp. 2072-2076.

[14] C. Siclet, Application de la theorie des bancs defiltres a I'analyse et a la conception de modulations multiporteuses orthogonales et biorthogonales, Ph.D. thesis, 2002.

[15] D. G. Luenberger, Introduction to linear and non-linear programming, Addison-Wesley publishing company, 1973.

[16] D. Pinchon, P. Siohan, and C. Siclet, "Design Techniques for Orthogonal Modulated Filterbanks Based on a Compact Representation," IEEE Trans. on signalprocessing, vol. 52, no. 6, pp. 1682 - 1692, June 2004.