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Research Article

An efficient novel approach based channel estimation and equalization scheme forhigh data rate FBMC/OQAM in 5G wireless channel

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ABSTRACT

This work aims at giving an insight into FBMC OQAM design for intrinsic interference reduction with improved spectral characteristics and maximal likelihood (ML) detector systems—its performance, co-channel interference (CCI) avoidance, and complexity reduction techniques related issues. Initially, performance metrics of FBMC QAM are analyzed with the CP-OFDM system to validate quality metrics. The quality trade-off measures over modulation order and BER performance of CP-OFDM and FBMC/QAM transmitting over selective fading channels are investigated and compared with simulation results. The simulation results show that the proposed FBMC QAM system outperforms conventional FBMC systems. Besides, it greatly reduces the performance penalty gap to OFDM, making this proposed FBMC QAM system attractive from both BER performance and implementation. Final at the downlink side, sub-detector enabled signal detection is accomplished using threshold driven statistical measures which precisely reduce the complexity trade off measure of ML detector over modulation order. Here BER performance metrics of the proposed FBMC framework were done with MATLAB simulation environments and its efficiency is proved through analyzes.

KEYWORDS: FBMC, Maximal likelihood (ML), CP-OFDM, Frequency selective fading channels etc.

1. INTRODUCTION

The filter-bank multicarrier (FBMC) system [1-2] has been promoted as an alternative technique to orthogonal frequency division multiplexing (OFDM) for next-generation wireless communication systems with the advantages as follows: i) out-of-band radiation reduction (low OOB emission), ii) CP-less symbol transmission, and iii) good time and frequency localization which gives robustness to the asynchronous environment. Though the FBMC system has numerous advantages over the OFDM system the lack of orthogonality between adjacent subcarriers is the major concern when quality metrics as a concern. To mitigate the problems, offset quadrature amplitude modulation (OQAM) [3] is used with the FBMC system. But the

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staggering structure of OQAM limits the FBMC system over direct integration of well known existing techniques such as channel estimation [4], PAPR reduction [5], channel equalization [6], and multiple-input-multiple-output (MIMO) [7] technique. To remedy these impairments, FBMC-QAM systems have been investigating many works in recent years. In addition to overcoming the spectrum shortages that will arise in next-generation wireless communication with improved spectral efficient FBMC system, large-scale multiple antenna systems should also be incorporated to meet the demands of high-end mobile traffic wireless environments. At one side due to its high spectral efficiency and its robustness to inter-symbol interference behavior of the frequency selective wireless channels in any multi-users environment multi-carrier modulation like FBMC has emerged as the most dominant wireless transmission technique for high-speed wireless systems. However, to achieve robustness to data transmission over time-varying channel characteristics and phase shifts diversity is required at the receiver side since FBMC is highly vulnerable to channel impairments.

2. RELATED WORKS

FBMC/OQAM achieves orthogonality in the real domain only. As a consequence the received symbols are not only accumulated with an intrinsic imaginary interference also complicates all other essential tasks at the receiver side. The feasibility of using QAM in FBMC to reduce the intrinsic interference is also getting emerged in recent years. The energy level and compactness requirements of 5G systems [8-9] present new challenges such as fully-integrated transceivers with least complexity and energy consumptions which is not directly applicable to any existing system models.

In wireless data propagation orthogonality plays significant role to reduce signal interference and improving quality of services. Moreover due to tremendous growth in the number of users need to be accommodated and high data rates with improved traffic rate demands for multiple antenna system exploitation is also emerged [10-11] In [12] reduce the intrinsic interference using coordinated beamforming enabled signal transmission with multi-user multiple-input-multiple-out (MIMO) systems for FBMC OQAM system. In [7] developed interference cancellation scheme based on partially estimation followed by low complexity Viterbi detector. In [8] developed channel estimation techniques for FBMC OQAM based on its intrinsic interference and its power efficiency outperformed conventional auxiliary pilot channel estimation method. This provides potential solution for FBMC/OQAM over intrinsic interference problem.

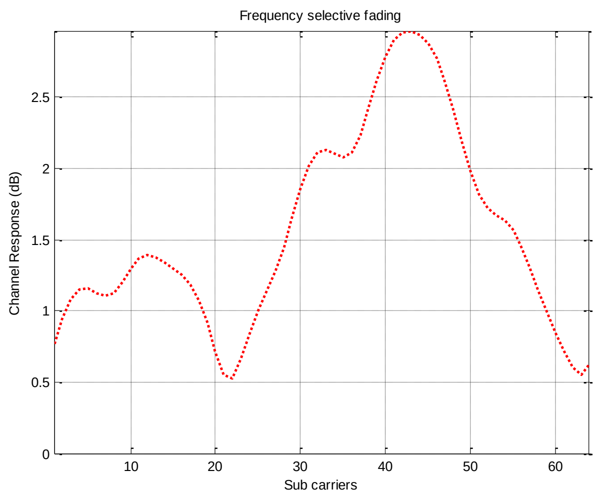
In [8] mitigate the multi-dimensional residual interference problem of FBMC QAM using diversity enabled MIMO based maximum likelihood detection at the receiver side and its improved BER performance with computational complexity overhead is also analyzes. In [9] proposed precoding scheme for FBMC QAM to solve the problems over orthogonality loss and quality degradation. Several quality enrichment methodologies are carried out at the receiver side to overcome the quality compromise due to the replacement of OQAM by QAM while retaining the spectral characteristics of FBMC system[10-14].

3. FILTER BANK MULTICARRIER (FBMC)

Among various methodologies investigated for future wireless communication filter bank multicarrier (FBMC) is considered as a prominent methodology that is useful for 5G communication and proved to be a potential alternative to exiting the CP OFDM system. Using the pulse-shaping filter, FBMC systems have reduced spectral side lobes than OFDM systems. Consequently FBMC attains asynchronous transmission. As FBMC is a multi carrier modulation system, the symbol interval widely extended by allocating the total frequency band into more sub bands. Due to this, FBMC systems are robust to this multi path fading channels.

$$x[n] = \sum_{k=0}^{M-1}\sum_{d=0}^{N-1} a_{k,d}\, g[n-dM/2]\, e^{j\frac{2\pi.k}{M}(n-Z/2)} e^{j\phi_{k,d}}$$

Where M is subcarrier or FFT length, g[n] is the filter coefficient, Z is the unit delay, φk,n is the phase term and finally ak,d is the real valued offset modulated symbol.



Channel response frequency selective fading model

3.1 Orthogonality

Orthogonality is essential for the perfect recovery of the transmitted symbols in multi carried modulation system. OFDM system achieves complex orthogonality by using a rectangular pulse in time .Because of the rectangular pulse the ambiguity function decays very slowly in frequency. However orthogonal characteristics of the transmitted symbols are impossible to maintain with severe channel conditions.

3.2 Frequency dispersive channels

Therefore, FBMC systems been observed as best possible physical layer methods in future communication systems. Moreover FBMC system is highly preferred choice for reliable communication in time and frequency dispersive channels as shown in Figure 1 and also for multiple access schemes. Filter Bank Multicarrier (FBMC) system is working with the basic principle of multicarrier (MC) system as like OFDM system by dividing the spectrum into multiple narrow sub-channels. In general FBMC is a multicarrier system with some shaping filter technique for orthogonality as shown in Figure 2.

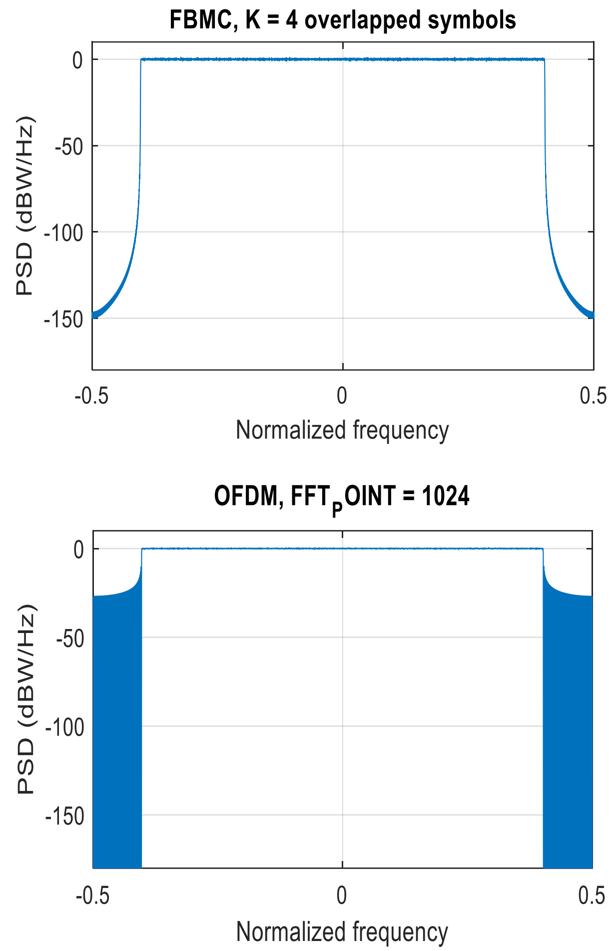
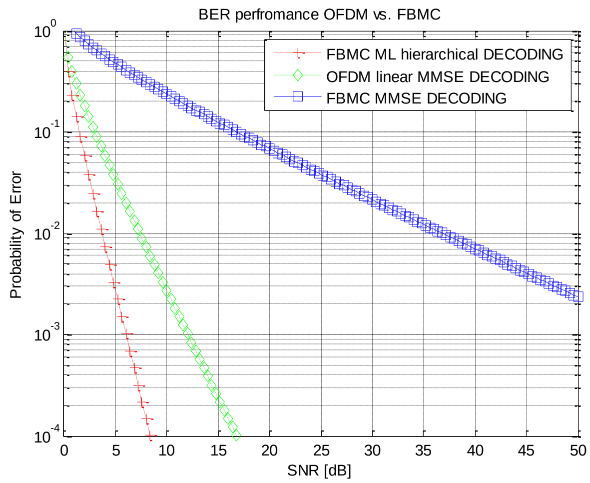


Fig.2. FBMC vs OFDM performance metric analyzes

4. SIMULATION RESULTS

The Figure 3 shows that theBit Error Rate performance analysis of FBMC OQAM over high mobility channel.The proposed systemFBMC OQAM with ML detector result is compared with the FBMC OQAM with MMSE detector. The simulation result is proved that the proposed system iss achieved the better performance than other methods. Obviously when the FBMC OQAM integrated with ML detector, the BER rate reduced which proves improved system performance. The simulation result is proven that and the error rate for the proposed system is quite lesser than the other method.



BER performance of FBMC ML vs MMSE over QAM modulation

4.1 Performance Analysis

Performance efficiency of proposed FBMC QAM system is analyzed using matlab simulation results and its penalty gap with conventional CP OFDM is verified. The Figure 3 shows that the Bit ErrorRate performance comparison among cyclic prefix OFDM MMSE and FBMC ML system.The proposed system FBMC ML QPSK lower order modulations is compared with OFDM MMSE-QPSK which implicit that both performances matches each other. Then the higher order modulation also matches with existing cyclic prefix –OFDM MMSE detector.

5. CONCLUSION

FBMC OQAM performance analyzes is carried out and also presented its robustness over channel with timing and frequency selectivity. The performance metrics of proposed FBMC OQAM over existing CP OFDM in terms of error rate performance also obtained through simulation results. The efficiency of FBMC OQAM over CP OFDM is also validated using various statistical measures. Based on simulations results simple linear signal detection model is not quite enough for considerable QoS. The results also indicated that FBMC OQAM can able to perform well and ML detection at the receiver side can able to orthogonality losses quite efficiently and also add reliability to accurate signal detection.

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