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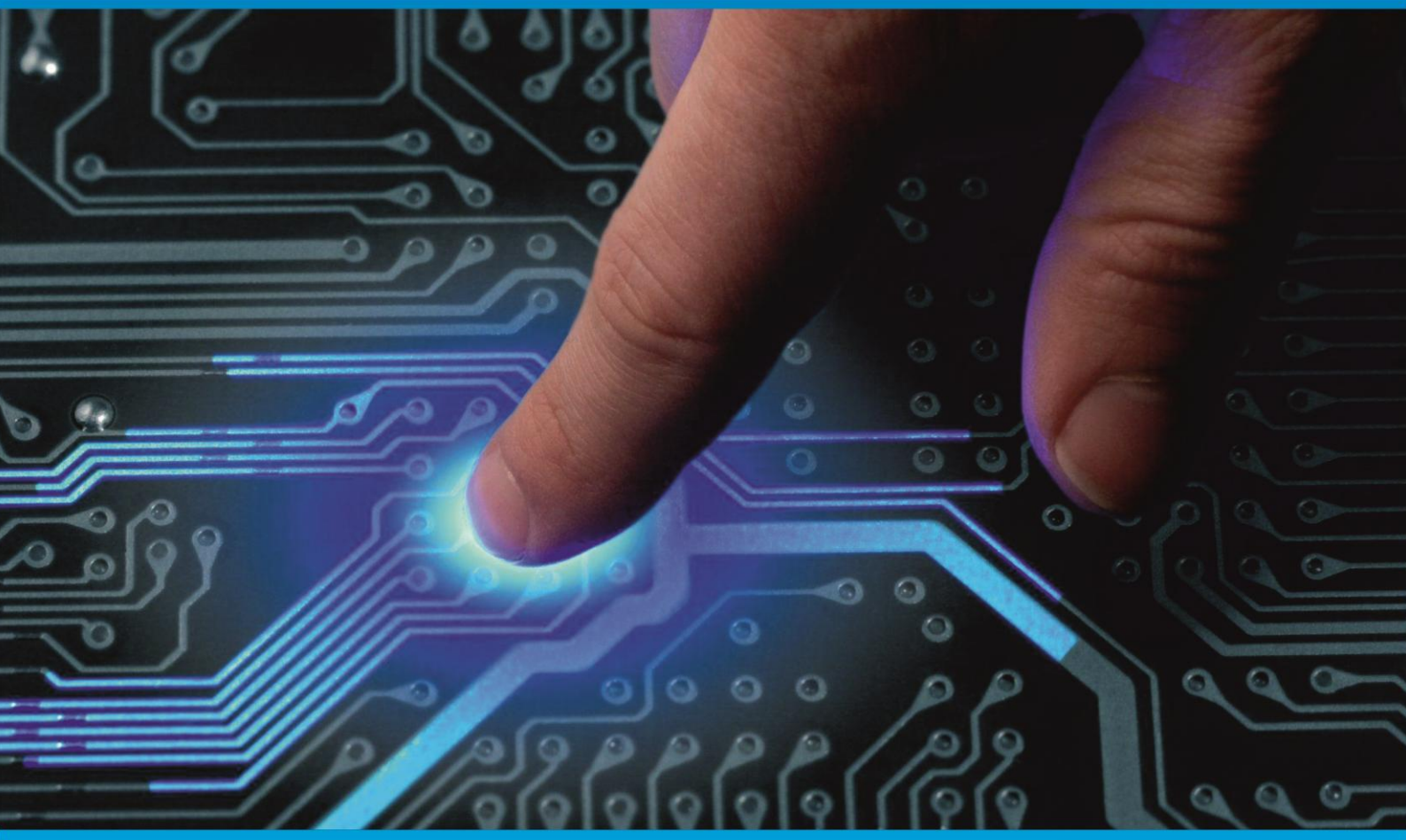
e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 8, Issue 10, October 2020

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.488

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | Impact Factor: 7.488 |

|| Volume 8, Issue 10, October 2020 ||

A Survey of Multiple Carrier Technique for High Spectral Density in 5G Wireless Systems

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ABSTRACT: In next generation communication systems high data rate and higher transmission capacity through wireless channel are important for researchers. Filter bank based multicarrier (FBMC) modulation with offset quadrature amplitude modulation (OQAM) makes researchers interested due to its advantages over orthogonal frequency division multiplexing (OFDM). The superiority and gains of MIMO processing can be used by FBMC/OQAM. Future wireless systems will be characterized by a large range of possible uses cases. This requires a flexible allocation of the available time-frequency resources, which is difficult in conventional Orthogonal Frequency Division Multiplexing (OFDM). Thus, modifications of OFDM, such as windowing or filtering, become necessary. Alternatively, we can employ a different modulation scheme, such as Filter Bank Multicarrier (FBMC). In this paper, a brief literature survey has done for future wireless communication techniques. Therefore FBMC replace the existing OFDM technique to meet high speed communication demand.

KEYWORDS: FBMC, OQAM, OFDM, MIMO, Channel Estimation, Time-Frequency.

I. INTRODUCTION

Wireless communication systems are used OFDM that is popular technology in many application [1-6]. FBMC system has developed in recent years and it has been an alternative to OFDM [7]. In widespread application, cyclic prefix (CP) required to use for OFDM in a practical multipath delayed channel. On the contrary FBMC don't need CP because of the advantage characteristic of the pulse shaping in stability opposite to multipath delay, which compared to general CP-OFDM and obtained an increase in spectral performance. Also interference of narrowband and guard band degradation between the channels is obtained FBMC many advantages because better stopband attenuation is enhanced with FBMC than OFDM. Because of between the adjacent pulses occur overlap in the space of frequency, FBMC symbols include interference.

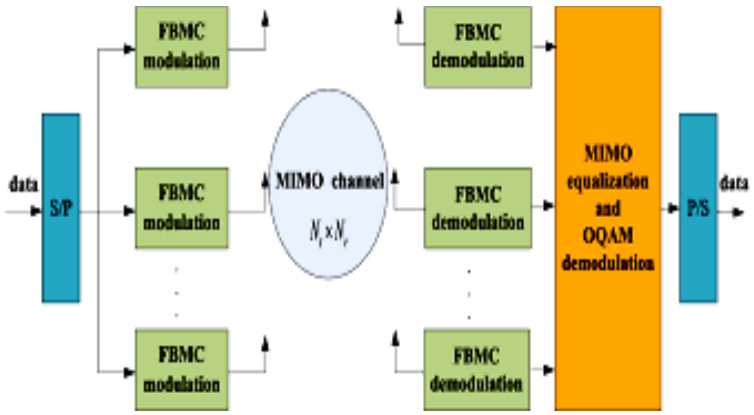

Figure 1: MIMO-FBMC

In addition transmission signal with overlap/sum is generated in the multiple FBMC symbols in the time domain so, inter symbol interference is occurred in the transmission signal. In literature mentioned interferences named as intrinsic interference. Offset quadrature amplitude modulation (OQAM) is used to maintain the orthogonality of adjacent pulses in the conventional FBMC, in which real detection is demodulated using each real valued symbol. But the FBMC system based on OQAM is not appropriate to cooperate with conventional MIMO techniques, owing to the available intrinsic interference. For this reason QAM based FBMC is getting attractive to researcher to eliminate the restrictions of OQAM and to design used QAM symbols a new prototype filter. QAM-FBMC structure is improved to transfer QAM symbols because of to cope with the deficit of OQAM-FBMC. Among QAM symbols placed null data increment

intrinsic interference in FBMC symbol assignment design. However, receiver has high complexity and because of high residual interference bit error rate (BER) performance is reduced.

In complex field with even and odd subcarriers is utilized to meet the orthogonality condition via designed two different prototype filters. In this technic QAM symbols can be obtained without any attenuation in performance of BER and without adding CP. When we use the two different prototype filters in QAM symbols transmitting, attenuation the side lobe of the prototype filter in the conventional QAM-FBMC is significant larger than OFDM. Owing to QAM-FBMC has smoothness response in the time domain. Therefore, QAM-FBMC must have a new prototype filter with good condition about side lobe must have confident performance with regard to BER in practical studies [8].

Future mobile systems will be highly heterogeneous and characterized by a large range of possible use cases, ranging from enhanced Mobile Broad Band (eMBB) over enhanced Machine Type Communications (eMTC) to Ultra-Reliable Low latency Communications (URLLC) in vehicular communications [1]–[5]. To efficiently support such diverse use cases, we need a flexible allocation of the available time frequency resources, as illustrated in Figure 1. There has been a lively discussion both, within the scientific community as well as within standardizations, which modulation format should be used for the next generation of mobile communication

II. RELATED WORK

H. Wang, et al., [1] 5G is expected to be the wireless communications technology in future smart city applications. Filter bank multicarrier employing offset quadrature amplitude modulation (FBMC/OQAM) technology is considered as a candidate transmission scheme for 5G. However, because of intrinsic interference, the commonly used channel estimation (CE)-based on preamble structure schemes in FBMC/OQAM systems are poor in CE performance, especially in multiple-input multiple-output (MIMO) systems. By exploiting the sparse nature of wireless channels, CE was developed as a problem of compressed sensing signal reconstruction. In this paper, a sparse CE approach for MIMO-FBMC/OQAM systems is presented. The proposed algorithm can realize accurate reconstruction of the channel by adaptively selecting the support set. The regularization process is also exploited to realize the second selecting of supporting atoms, although the channel sparsity is not given previously.

M. J. Bocus, et al., [2] In this work, it is assess the transmission of a standard definition (SD) video over a 1000 m vertical time-varying underwater acoustic channel (UAC) using multiple-input multiple-output (MIMO) systems with spatial multiplexing gain. The MIMO systems are integrated with filter bank multi-carrier (FBMC) modulation and Orthogonal Frequency Division Multiplexing (OFDM) and their bit error rate (BER) performances are evaluated over the channel using preamble-based channel estimation. In this work it is chose to use the FBMC system based on the Offset Quadrature Amplitude Modulation (OQAM) as it achieves maximum spectral efficiency. Simulation results show that MIMO-FBMC/OQAM provides a better error performance than MIMO-OFDM in the UAC, outlining its robustness against both time and frequency dispersions.

B. Kamislioglu et al., [3] In next generation communication systems high data rate, and higher transmission capacity through wireless channel are important for researchers. Filter bank based multicarrier (FBMC) modulation with offset quadrature amplitude modulation (OQAM) makes researchers interested due to its advantages over orthogonal frequency division multiplexing (OFDM). The work indicates that OFDM, FBMC-QAM, multiple-input multiple output (MIMO) transmission layouts and channel estimation layouts study same logic. Also MIMO receiver design is realized for FBMC such as ZF, MMSE, ML techniques. Finally, FBMC-QAM and OFDM is compared about magnitude response, amplitude of subcarriers in frequency and BER performance and MIMO receiver techniques are compared about SER to SNR.

F. Rottenberg et al., [4] This work investigates downlink channel estimation in a distributed MIMO context employing Filter Bank-based Multi-Carrier Offset QAM (FBMC-OQAM) modulation. Training preambles are constructed based on two different subcarriers assignment schemes (SAS), with the aim of freeing the estimation procedure from the effects of the multi-stream interference (MSI). The Linear Minimum Mean Squared Error (LMMSE) estimator is considered for computing estimates of the channel frequency responses over the entire frequency band and shown to be robust to ill-conditioning associated with the SAS. The application of the different SAS to FBMC-OQAM is evaluated via simulations in an unsynchronized scenario. The performances are compared with the corresponding fully synchronized CP-OFDM scenario. The results demonstrate the robustness of FBMC-OQAM to asynchronism and reveal the advantages of each SAS in various situations.

C. Mavrokefalidis et al., [5] The problem of adaptively equalizing doubly dispersive MIMO channels for FBMC/OQAM systems is studied in this paper. The challenges in this type of multicarrier systems include their intrinsic self-interference and the need to cope with time- and frequency-selective subchannels in realistic propagation conditions. An efficient and numerically stable algorithm is adopted, relying on a decision feedback structure that implements BLAST ordering for the input signals recovery. The ability of this algorithm to address the above

challenges has been demonstrated. The focus of this work is on reducing the needs of this equalizer in training information. A channel estimate-based (re-)initialization scheme is developed and shown to be quite effective in lowering the training overhead, at an affordable additional cost in complexity. For the sake of comparison, the MIMO-OFDM problem is also studied. Simulation results for practical scenarios demonstrate the effectiveness of the proposed approach.

R. Zakaria, et al., [6] In this paper, the filter-bank multicarrier (FBMC) system is considered, and it is deal with the presence of the inherent intersymbol interference (ISI). Indeed, the transmitted data symbols in FBMC are OQAM (Offset QAM) modulated, and the received data symbols are corrupted by inherent interference terms which complicate the detection in a maximum likelihood (ML) sense in the spatial multiplexing scheme. Detection schemes with ISI estimation and cancellation are not always effective due to the error propagation. it is propose in this work to modify the conventional FBMC system by transmitting QAM data symbols instead of OQAM ones in order to reduce the inherent interference. Then, it is propose a receiver based on ISI estimation and cancellation. A simple tentative detector is first used to attempt to cancel the ISI before applying the ML detection.

M. Bellanger et al., [7] A filter bank multicarrier (FBMC) system having a high level of compatibility with the IEEE P1901 OFDM scheme is proposed. In order to reach the level of robustness, selectivity and performance required by the broadband power line, the approach is based on near perfect reconstruction (NPR) filters combined with OQAM modulation. A key feature of the approach is the fractionally-spaced sub-channel equalizer, which is able to compensate the channel distortions and cope with residual timing offsets. The system initialization procedure and the results of OFDM are exploited by FBMC and an efficient and accurate technique is described for the derivation of the sub-channel equalizer coefficients from the OFDM frequency domain equalizer coefficients. Then, the impact of the filter impulse response on the efficiency in packet transmission is minimized. Finally, the impact of the sub-channel spacing is investigated and, in a comparison on similar basis, it appears that the proposed FBMC system can reach 228 Mbit/s in maximum bit rate, versus 197 Mbit/s for OFDM, while providing a higher level of tone protection and robustness to jammers.

D. S. Waldhauser et al., [8] Filter bank based multicarrier systems (FBMC) offer a number of benefits over conventional orthogonal frequency division multiplexing (OFDM) with cyclic prefix (CP). One benefit is the improved spectral efficiency by not using a redundant CP and by having much better control of out-of-band emission. Another advantage is the ease of accommodating multiple users in an FDMA fashion especially in the uplink, i. e. the multiple access channel (MAC). On the other hand, more elaborate equalization concepts are needed compared to the single-tap per-subcarrier equalizer sufficient in the OFDM with CP case. Therefore, it is will present a least-mean-square (LMS) algorithm which is adapted to the principle of orthogonally multiplexed QAM filter banks (OQAM-FBMC). This leads to an adaptive equalizer solution with low complexity. The initialization of the LMS equalizer results from a pilot based channel estimation.

Table 1: Summary of literature survey

Sr No	Author Name & Year	Proposed Work	Outcome
1	H. Wang IEEE, 2018	A sparse CE approach for MIMO-FBMC/OQAM systems	Compressed sensing approach for CE outperforms better
2	M. J. Bocus IEEE, 2018	FBMC system based on the Offset Quadrature Amplitude Modulation	Better error performance, robustness
3	B. Kamislioglu IEEE, 2017	OFDM, FBMC-QAM, MIMO, transmission layouts and channel estimation layouts	BER performance and MIMO receiver techniques are compared about SER to SNR.
4	F. Rottenberg IEEE, 2015	Filter Bank-based Multi-Carrier Offset QAM (FBMC-OQAM) modulation.	Robustness of FBMC-OQAM and reveal the advantages of each SAS in various situations
5	C. Mavroke IEEE, 2015	Adaptively equalizing doubly dispersive MIMO channels for FBMC/OQAM systems	MIMO-OFDM problem is also studied, effectiveness.
6	R. Zakaria IEEE, 2012	Receiver based on ISI estimation and cancellation	ISI cancellation is effective and the performance converges to the optimum one.
7	M. Bellanger IEEE, 2010	Fractionally-spaced sub-channel equalizer	Reach 228 Mbit/s in maximum bit rate, versus 197 Mbit/s for OFDM
8	D. S. Waldhause IEEE, 2008	least-mean-square (LMS) algorithm	Loss in data rate is compensated with a higher modulation scheme

III. CHALLENGES AND APPLICATION

Filter bank Multicarrier (FBMC) has been proposed by researcher as an alternative to Orthogonal Frequency Division Multiplexing (OFDM) in the multicarrier modulation scenario.

- One disadvantage of using FBMC is the need for multi-tap per subcarrier equalization, unlike the single tap equalization in OFDM.
- There has been research in the field of MIMO which suggest a channel frequency flattening phenomena, which has been mentioned in literature as channel hardening, self equalization and so on.
- When FBMC is combined with MIMO, the equalization complexity required is seen to be reduced.
- There are many challenges combining FBMC and MIMO. FBMC-Offset Quadrature Amplitude Modulation (OQAM) is proposed as a modulation technique to replace OFDM.
- We show that there are many practical difficulties for FBMC-OQAM-MIMO. So we propose a FBMC-QAM-MIMO technique.
- We look at many disadvantages of FBMC-OQAM that is already in literature as well as the difficulties that we have observed.
- We explain how FBMC-QAM can overcome these difficulties. Channel flattening in FBMC-QAM-MIMO is also looked at in detail.
- It is explained by effective impulse response of a MIMO channel. We look at its performance when one tap equalization is used. Performance of one tap equalization for different waveforms is compared with OFDM.
- Filter bank multicarrier aims to overcome some of the shortcomings that were encountered with OFDM, orthogonal frequency division multiplexing.
- Using banks of filters that are implemented, typically using digital signal processing techniques, FBMC.

IV. CONCLUSION

Filter bank multicarrier (FBMC) is an alternative transmission method that resolves the above problems by using high quality filters that avoid both ingress and egress noises. Also, because of the very low out-of-band emission of subcarrier filters, application of FBMC in the uplink of multiuser networks is trivial. In the past, many attempts have been made to adopt FBMC in various standards. Apparently, the earliest proposal to use FBMC for multicarrier communications is a contribution. Recent discussions on the fifth generation (5G) wireless communications have initiated a much stronger wave of interest in deviating from the main stream of OFDM systems. This shift of interest is clearly due to limitations of OFDM in the more dynamic and multiuser networks of future. A number of proposals have been made to adopt new waveforms with improved spectral containment. This paper reviews of all possibility to use and enhance application of FBMC with OQAM. In future it will be implemented using simulation software and proved its validation.

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| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | Impact Factor: 7.488 |

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