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Filter Bank Multicarrier Transceiver based Filter Optimization MIMO System: A Study

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ABSTRACT: In the FBMC multicarrier waveform approach, the individual subcarriers are filtered using non-rectangular pulse shaping filters. The FBMC signal expands over K symbol intervals. It therefore overlaps with K subsequent FBMC symbols. Different subcarriers are individually pulse-shaped rather than pulse-shaping the whole band. When orthogonality with cyclic prefix occurs in subcarriers, it results in a reduction of spectral efficiency. The length of the impulse response of transmit filter is four times the symbol length because of the narrow bandwidth of subcarriers. If transmitted symbols are large, good spectral efficiency is achieved. Offset QAM (OQAM) mapping is used by FBMC to maintain real field orthogonally and achieve full system capacity. FBMC requires no CP transmission. Due to the inclusion of band-limited pulse shaping filters into the signal model in FBMC technique, the design of efficient transceiver architectures for multicarrier systems becomes a challenging task. In this paper the studied of MIMO technique for FBMC transceiver for 5G technologies is presented.

KEYWORDS: Filter Bank Multicarrier (FBMC), Filter Bank, MIMO System

I. INTRODUCTION

In every decade, new generation of wireless communication system is launched. The functioning of cellular system for mobile communication is begun in the year 1981 through First generation (1G). This technology based on analog in nature and offered poor spectrum utilization and security features. In the year 1992 based on digital modulation techniques; the Second generation (2G) was deployed. It is primarily meant for voice and very low data transmission. To provide high data rate and to enhance voice security features Third generation (3G) was made available for communication in the year 2001. In third generation (3G) communication system apart from mobile telephone, new modes of communication systems takes place major part, such as WLAN protocols, Bluetooth and 802.11 protocol suits. Third generation cellular mobile communication system offered high speed data rate and greater bandwidth utilization for the users. Fourth generation (4G) was developed in the year 2011, for efficient utilization of available bandwidth, long range connection of the devices and high speed real time data transmission. As this is the 4G era, wireless communication is moving towards providing high speed connectivity to costumers through IP (Internet Protocol) based technology and Long Term Evaluation (LTE) systems. As the requirement for bandwidth increases, the next generation wireless communication will gain more demand compared to present 3G and 4G systems. The innovations of new wireless communication systems have their phases of development and decay sooner or later. It is very uncertain whether next generation is beginning new era in the year 2020. Currently fourth generation (4G) cellular mobile communication system was established and publics are experiencing services. Still they are looking towards the deployment of fifth generation (5G) technology to experience more advancement in new technologies. Based on the present research studies 5G technologies for cellular mobile communication systems can come to end result around 2020. Because the development and establishment of any cellular system is requires several years. The 5G cellular mobile communication devices are quick enough to communicate with each other compared with 4G and LTE systems. And also, 5G is relied upon to accomplish enhanced framework limit and throughput. The main aim of 5G research and development is to improve device-to-device communications, at lower cost, lower latency and better implementation than previous generation. This can be enabled by developing sophisticated machines, like advanced field programmable gate arrays and digital signal processors. These hardware devices allow the use of efficient algorithms implementation for communication system. The potential applications of 5G technology is to facilitate to the users for high speed video downloads, vehicle-to-vehicle communications, and general cellular communication systems.

II. LITERATURE REVIEW

Emad S. Hassan et al. [1], as a multi-carrier modulation (MCM) strategy for upcoming communication systems, the filter bank multi-carrier (FBMC) method is receiving a lot of attention. It offers various benefits in difference to Symmetrical Recurrence Division Multiplexing (OFDM). Regardless, like numerous other MCM strategies, FBMC experiences a huge test with a high Pinnacle to Average Power Proportion (PAPR). In addition, the presence of complex interference and increased computational complexity make the integration of Multiple-Input and Multiple-Output (MIMO) into FBMC more challenging. In this paper, we first review the exhibition examination of MIMO based Quadrature Sufficiency Tweak (QAM)- FBMC frameworks thinking about the framework intricacy and obstruction. To upgrade inclusion successfully utilizing beamforming with different radio wires, it is fundamental to lessen PAPR to limit the info backoff (IBO) expected by nonlinear power speakers. Subsequently, we propose new PAPR decrease technique for MIMO based QAM-FBMC frameworks utilizing the invalid space inside the MIMO channel utilizing cutting and sifting (CF) procedure. After that, each frequency block's PAPR reduction signals are mapped to the null space of the MIMO channel as a whole. We show that the proposed approach significantly outperforms conventional approaches in terms of PAPR and throughput for MIMO-based FBMC systems through computer simulations using a nonlinear power amplifier model.

Qi Y. et al. [2], a response difference phenomenon that reduces the equalization performance of massive multiple-input multiple-output (MIMO) systems based on offset quadratic amplitude modulation filter bank multi-carrier (FBMC/OQAM) is established. We propose a low-implementation-complexity multi-tap equalizer design scheme based on multi-stage equalization as a solution to this problem. The plan can mitigate the effect brought by the peculiarity really and further develop the balance execution altogether. In addition, we investigate the proposed scheme's signal-to-interference-plus-noise ratio (SINR) and ergodic achievable rate performance and elaborate on its self-equalization property, which states that as the number of BS antennas increases, inter-user noise and interference disappear. For this situation, there just remaining parts some lingering obstruction inside a similar client, which is sufficiently small to be disregarded. When the channel response is unit impulse, SINR can therefore approach the upper bound of the signal-to-interference ratio (SIR), also known as the SIR in a single-input, single-output (SISO) scenario. The simulation results show that the proposed scheme with a shorter equalizer length can perform better than other schemes with longer equalizer lengths, which is consistent with the performance analysis. In addition, even with limited number of BS radio wires, the impedance brought by the channels can be practically disposed of.

H. Yamada et al. [3], looks at the exhibitions of channel bank multicarrier (FBMC) and symmetrical recurrence division multiplexing (OFDM) under multipath blurring channels, with regards to their hypothetical framework limits. OFDM produces elevated degrees of out-of-band (OOB) radiation while being impervious to between image obstruction (ISI). In contrast, the effect of subcarrier-wise filtering in FBMC reduces adjacent channel interference (ACI) and the generation of OOB radiation. However, multipath fading results in ISI and inter-carrier interference (ICI). The essential point of this study is to show the hypothetical framework limit of FBMC and OFDM frameworks, think about their ACI and multipath blurring in a nonconcurrent situation, and find out the prevalence of each approach in light of the boundaries of watchman band and postpone spread.

A. Nasri et al. [4], one of the most significant issues in orthogonal frequency division multiplexing (OFDM) is the peak-to-average power ratio (PAPR). In OFDM systems, iterative clipping and filtering (CF) is a high-efficiency method for reducing PAPR; however, in order to minimize the peak regrowth issue, multiple iterations are required. A novel, one-iteration CF method is presented in this paper. The previous approach requires $2K+1$ IFFT/FFT blocks, where K is the number of iterations. The number of FFT and IFFT operations has been reduced to three by employing this algorithm. The reproduced results show that the QPSK tweaked OFDM signal with 528 sub-transporters accomplishes a P APR decrease of 6.1 dB by passing the OFDM signal from white Gaussian commotion channel with a decent piece mistake rate execution at the recipient.

A. Mobin et al. [5], have multicarrier waveform technology known as Filter Bank Multicarrier (FBMC) has low synchronization requirements, minimal out-of-band (OOB) leakage, and high spectral efficiency. FBMC is a suitable multicarrier waveform technique for 5G and future wireless networks thanks to these properties. FBMC, as other multicarrier waveform plans, has a high top to-average-power proportion (PAPR) issue. For PAPR reduction of FBMC-offset QAM (OQAM) systems, this paper investigates logarithmic rooting companding. Its' presentation is contrasted and other nonlinear companding procedures, for example, μ -regulation, A-regulation, establishing and digression

establishing, that are utilized for PAPR decrease of FBMC-OQAM frameworks. In terms of PAPR reduction, it outperformed previously investigated methods, but its bit-error-rate (BER) performance was comparable to that of rooting and tangent rooting techniques and significantly lowers than that of -law and A-law companding methods. A trade-off between PAPR reduction capability and BER performance was also observed when the companding parameters of logarithmic rooting companding were selected appropriately.

Imad A. Shaheen et al. [6], as we will see later, the extra sifting in the UFMC flag age brings about the way that little planning balances don't make any impedance to transmissions from different UEs in neighboring asset pieces. Be that as it may, an extra planning estimation step is required at the eNB. UFMC along these lines empowers the transmission of short bundles without the necessity of experiencing the full connection system. At the point when a UE awakens, it simply needs to synchronize the phone on the DL in both recurrence and time, however as opposed to transmitting an introduction on the physical arbitrary access channel (PRACH) to start the association and permit the eNB to gauge and flag the planning development to the UE, it basically transmits its information utilizing the proposed UFMC transmitter on the same PRACH assets.

Zongmiao He et al. [7], filter optimization of out-of-band emission [7] plays an important role for FBMC-OQAM system. The main idea of this paper is to minimize the stopband energy with constraints of side lobe and inter channel interference (ICI)/inter symbol interference (ISI) by optimizing the filter coefficients. The main contribution is that the improved approach reduces the stopband energy and suppresses the side lobe simultaneously with nearly perfect reconstruction (NPR) condition. Simulation results show that the improved filter reduces the stopband energy and the side lobe more than the optimized windowing based filter. Meanwhile, the improved filter has almost the same bit error rate (BER) performance as the optimized windowing based filter for FBMC-OQAM system in additive white Gaussian noise (AWGN) channel.

Mawlawi, B. et al. [8], initial 5G organizations should be in reverse perfect with existing 4G frameworks, i.e., a 5G eNB likewise needs to help 4G UEs. UFMC can be effortlessly coordinated into the uplink (UL) of existing 4G frameworks by essentially supplanting the last advance of the SC-FDMA flag age with a UFMC modulator (see Fig. 1). The collector of the eNB can stay unaltered and will work ordinarily if the UE is completely synchronized to the system. With this system, they guarantee that if the traditional plan of UFMC transmitter has unpredictability of 150 times that of CP-OFDM at that point applying recurrence area arrangement the multifaceted nature decreases to 120 times that of CP-OFDM.

III. FILTER BANK MULTICARRIER (FBMC) TECHNIQUE

The filter bank multicarrier scheme was introduced first time by Saltzberg and Chang in the year 1971. FBMC is also a family of OFDM technique. In the beginning this approach were adopted to support the OFDM technique. The main intention to identify this technique is to overcome the limitations of existing multicarrier modulation schemes. FBMC uses specific pulse shaping filters which generates good confine sub-band in time and frequency domain with the help of filter bank and its poly phase structure. In communication system, digital signal processing signals have high bandwidth in the range of GHz. Most of the presently available FPGA's and DSP Hardware kits are having clock rate in the range of some MHz's. In order to reduce the clock frequency, multiplexing techniques are used to sort out the required data rate at lesser clock frequency.

As many subcarriers are covered within the bandwidth of the filter, this waveform can have a short impulse response. This means that good spectral efficiency is achieved in transmissions that are short bursts. This waveform does not require any CP and filters can be designed to get a block length that is equal to CPOFDM. However, this waveform is complex to time misalignment. So, UFMC is not appropriate for loose time synchronization applications. The strength of UFMC is a low filter length in comparison to subcarrier-wise filtering, good frequency localization, and compact with MIMO. The Weakness of UFMC is high receiver complexity and non-immunity to ISI due to a lack of CP.

The efficient way of achieving this task, is through adopting filter bank multicarrier modulation (FBMC) technique for sub-band processing of input signals. FBMC is considered as a promising alternative multicarrier technique for future communication systems. The next generation of mobile communications (5G) is ambitious by more spectral efficient wave-forms. FBMC has gained a high degree of interest to provide flexibility for 5G mobile communications system, as a 5G waveform candidate. In the advancement in digital signal processing (DSP) capabilities, research has been

carried out to identify alternative to existing multicarrier modulation technique for next generation communication system.

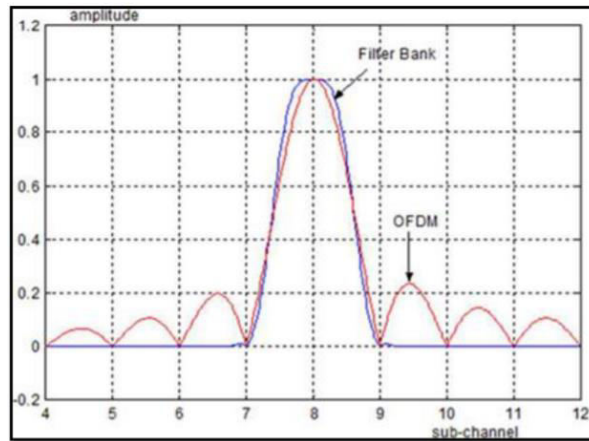


Figure 1: Time domain response of FBMC prototype filter and OFDM technique

Due to the finite transition region at the end of the FIR pass band, small gaps are produced between the sub-bands, which avoid crosstalk and spectral leakage. Analysis filter bank is used at transmitter for sub-band processing of higher band into several lower band signals with the help of decimation filter. After processing of signals, Synthesis filter bank is used at receiver to form a replica of the original signal, using interpolator based on the sub-band channels. Finally, sub-band channels are recombined into a full band output signal.

IV. BLOCK DIAGRAM OF FBMC

Most of the investigated and analyzed new communication techniques are algorithmic stage. Hardware and software implementation cost are considered as main parameters required for future mobile communication systems. But, for practical implementation of any wireless communication system are bound by many parameters. These parameters include economic, social, hardware complexity and essential need of users. These constraints can be achieved effective use of resources and technology. Therefore, this thesis mainly deals with design and implementation of advanced and efficient hardware architecture, which may be suitable for the physical layer of future communication (5G) transceiver architecture prototype on FPGA. With this essence, a novel hardware architecture design for future communication (5G) system, based on Filter Bank Multicarrier modulation technique is presented. This technique is being studied and considered these days by recent researches for the future adoptable 5G air interface. It provides enhanced range of spectrum compartment compared to conventional multicarrier modulation technique and allows enhanced mobility management. There are some other alternative and subcategories for FBMC as well.

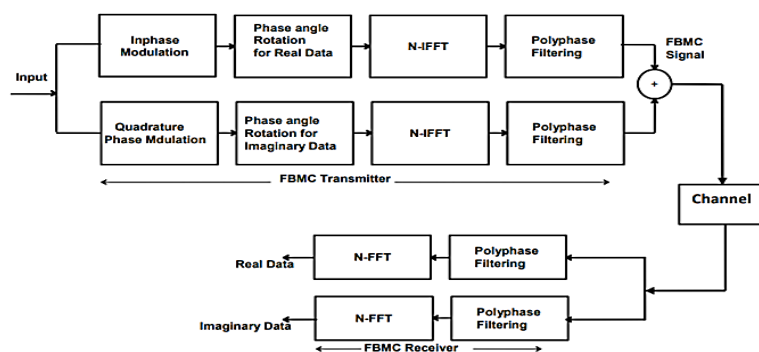


Figure 2: Block diagram of FBMC transceiver

V. PROPOSED METHODOLOGY

There are different categories of prototyping transmitter for FBMC transceiver. Many FBMC transmitters are designed using NK-IFFTs and it requires more signal processing operations. And also, it requires more computational complexity to reduce the complexity in IFFT and avoid the overlapping of signals in the receiver instead of parallel implementation of NK-IFFTs; we are only utilizing 2 N-IFFTs. Where N indicates number of inputs and K represents overlapping factor of each sub-band. So the range of the impulse response is $L = NK$. To construct the FBMC signal it performs the Inverse - Fourier transforms (IFFT) both sides and then it performs the poly phase filtering.

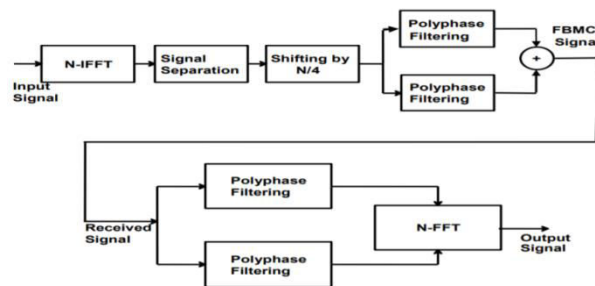


Figure 3: Simplified FBMC transceiver

The multiplication of IFFT with phase rotation vector θ_k in frequency domain leads to circular shift of $N/4$ in time domain, which results in reconstruction of the FBMC signal N-IFFT Signal Separation Shifting by $N/4$ Poly phase Filtering Poly phase Filtering + FBMC Signal Input Signal Poly phase Filtering Poly phase Filtering Received N-FFT Signal Output Signal by utilizing two poly phase filter modules as depicted in the above Figure 3. To construct the FBMC signal in transmitter, we can use NK-IFFT and Poly phase filters. In receiver, we may use poly phase filtering stage and NK-FFT to recover data. In order to retrieve the original signal back, pipelined FFT Architecture is used. By using pipelined FFT Architecture it is easy to compute higher FFT point by making short variations in the code. Therefore, with this architecture, the complexity level and area utilization get reduces while the speed of communication system improves.

VI. CONCLUSION

FBMC systems were analysed over AWGN and Rayleigh flat fading channels. In the future it is recommended to analyse the proposed FBMC systems over frequency selective fading channels. In this work perfect channel estimation is assumed at the receiver side. In the future different channel estimation and equalization algorithms can be studied when channel impulse response is unknown at the receiver side. A similar channel bank can be utilized for transmission and reception in FBMC transceiver architecture which ensures low BER and high performance compatibility in terms latency and throughput. The out-of-band reduction of the prototype filter amplitude curve in FBMC system assures spectral preservation of other subscribers which leads to new physical layer containment for future communication system.

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