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Analysis of FBMC peak to average Power Ratio Reduction by Using MIMO-OFDM based FPGA Implementation for 5g Technologies

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Abstract:

The recent research on communication systems has found that, because of its high spectral efficiency, multicarrier (MC) techniques are more desirable for the development of modern wired or wireless communication systems. So far, the most common modulation technique in 4th (4 G) and Long-term Evolution (LTE) systems is orthogonal frequency multiplexing (OFDM). The low frequency range of subcontractors within OFDM systems, given its various advantages, limit the applicability of some present and future communications systems such as Cognitive radio (CR) and Dynamic spectrum access (DSA). Multicarrier Filster Bank (FBMC) is an revolutionary OFDM technology that solves most of the problems by using a multi-carrier communication network filtering approach. FBMC signals easily follow the CLAR and do not use the cyclic prefix to increase spectral efficiency. The transmission method Filter Bank Multicarrier (FBMC) contributes to improved physical layers for future communication networks and is a cognitive radio-based technology. Multimedia data services demand has risen rapidly in the recent past. Orthogonal Frequency Division Multiplexing (OFDM) is one of the most promising multi-carrier technologies for all 5 G wireless communication networks due to its high power, high data rate and universal coverage with high mobility. The peak-to-average power ratio (PAPR) is significantly influenced by OFDM. Unfortunately, with the high PAPR intrinsic to OFDM signals, high-power amplifiers (HPAs) are often worked on its characteristic curve in the nonlinear region. The key emphasis of this paper is the MIMO-OFDM network PAPR reductions by partial transmission sequences (PTS) and precoding methods. Other methods like the clipping of amplitude have little difficulty. On the other hand, they have issues such as distortion of the in-band and expansion of outside-band. The methods of signal compounding have low complexity, strong distortion and spectral properties but restricted potential for PAPR decrease.

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I. INTRODUCTION

Communication is a crucial problem that allows people to communicate across the globe. Communication has grown rapidly over the past centuries through electronic media, such as telephones, TV and radio. There has been tremendous growth in contact infrastructure over the past 50 years. Higher outputs and limitations have replaced wireline communication due to demand for new technologies. Presently, wireless networking replaces most of the wireline communication networks. Now, because of many reasons, the popularity of wireless communication has grown more in comparison with wired communication. In the field of mobile communication, rapid growth and creativity are evident. This made mobile communication more cost-efficient and effective.

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With the increasing need for applications of mobile communications network systems, complexity in this area has increased. The term Mobile Communication refers not to wires, wires or any other power conductor, but to the form of contact or data over a distance. The transmitted data is in the form of binary sequences in cellular mobile communication.

In this age of communication, OFDM is a multi-carrier modulation technique which is a effective way of carrying high speed data streams along the path of intersymbolic (ISI) interference[1] on multipath fading. A cyclic prefix is added to delete ISI, but this can greatly decrease bandwidth capacity. DWT-OFDM system replaces systems such as DFT-OFDM and DCT-OFDM during recent studies. Due to overlapping techniques, the DWT-OFDM cyclic prefix is not necessary and provides robustity against ISI because of the limited duration of subcontractors.

Fifth (5 G) innovation is planned in the most advanced and flexible operating environment to offer fantastic and wonderful information, unhindered call volumes and limitless information. It is therefore a cleverer invention that unboundedly interconnects the entire planet. 5 G provides a non-exclusive means of ensuring a much more versatile and inclusive organisation, taking into account the purpose of adaptation to heterogeneous circumstances and needs.

This will integrate with the associated systems in established and scalable management systems.OFDM was proposed to support rapid transmission of information over remote connections in multipurpose cases as a transmission technology. OFDM has developed a popular program for advanced broadband connectivity over the last forty years, whether remote or over wires, as part of uses such as computerized and sound-based TV, remote systems management and broadband website access[6]. In their signal processing loop, OFDM also used digital-to-analog (DAC) and analog-to-digital (ADC). A high precision DAC and ADC, which is extremely expensive for a given inspection rate of the system, is necessary to support high PAPR. Although the DAC and ADC are lower in precision, their concussion with amounts is noteworthy and thus decreases the snr as the dynamic range of DAC and ADC increases in support of a high PAPR. In this context, a decrease in PAPRs is necessary in order to achieve better electricity output, broad territories and low BERs in an OFDM system. Many wireless communication systems used a large-scale HPA at the transmitter output to achieve adequate transmitting power.

The HPA is typically used in or close the saturation area to achieve optimum power output. When such an HPA is passed by a high peak power signal, peaks are cut off not linearly and intermodulation distortion at the output is induced. Any further intervention raises the amount of BER. For many years MIMO for wireless systems has been built. One of the first MIMO systems for wireless communications was created in the middle of 1980. Several academics and engineers have contributed significantly to the field of MIMO since then.

II. Literature Review

For today's portable mobile communications network OFDM is commonly used multi-carrier modulation technology. Many architectures to improve the efficiency of the OFDM framework were presented. It can be considered not to be a good candidate for 5G or Cognitive Radio because of spectral leakages in multiple-career modulation techniques focused on OFDM. Therefore, the latest FBMC transceiver architecture for future communications systems is discussed in this study. Inverse Fourier Transform and Fast Fourier (IFFT / FFT) Blocks are used by the FBMC transceivers along with polyphase filter banking systems.

Robert W. Chang (1966) introduced the principles of the orthogonal frequency division multiplexing, with the maximum information rate, through which information was transmitted via a band-bound transmission system. For transmission (N = 2) amplitude Modulated information is used a guidance

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on orthogonal multiplexing through a direct band-restrained transmission medium. The channels operate on the same center frequencies and synchronize information. Binary numbers, M-ary digits or actual numbers can be transmitted by any wave.

The Fast Fourier transform and Inverse Fourier transform engine to the MIMO technology were proposed by Yu-Wei Lin etc. (2007). These algorithms are based on the feedback framework for multi-way delays. Results and review show that the use of FFT / IFFT engines in this strategy eliminates the usage of DFT hardware and resources.

Ryoji Hashimoto et.al (2009) developed OFDM baseband transceiver architecture for spectrum access. In order to make dynamic spectrum access possible, OFDM transceivers architecture uses larger FFT / IFFT engines. Carrier sensing can be done in the desired manner with the aid of the FFT processor. For the consistent use of IEEE 802.11 g wireless communication standards, a prototype system is designed. The results show that in slice registrations and in logical gates this architecture uses the lower limit.

Diverse high-data rate wireless networking systems have widely used the Orthogonal Frequency Division Multiplexing (OFFM). However, in OFDM systems, the high maximum-to-average (PAPR) ratio has been recognized as a constant issue. The high PAPR of the OFDM system has led to many problems, including signal distortion, energy discharge to the adjoining channel and a progressive decrease in system efficiency. This paper presents a technique that uses a circulating shift to control a codeword. Scramble data sequences, such as the traditional selective mapping (SLM) method, are the key concept of the proposed method.

III. Principle Concept of Ofdm System

Figure 1. Consider an input binary sequence which is seen in the DFT / FFT OFDM method and converted by demutiplexing to N parallel streams. Each of these data streams is transformed into symbol streams, whereupon IDFT / IFFT is done to obtain complex collection of signal time domain samples for this collection of samples.

By using digital to analog converters, these samples are converted into analog domain. A mixture of all analog signals will obtain the transmission signal.

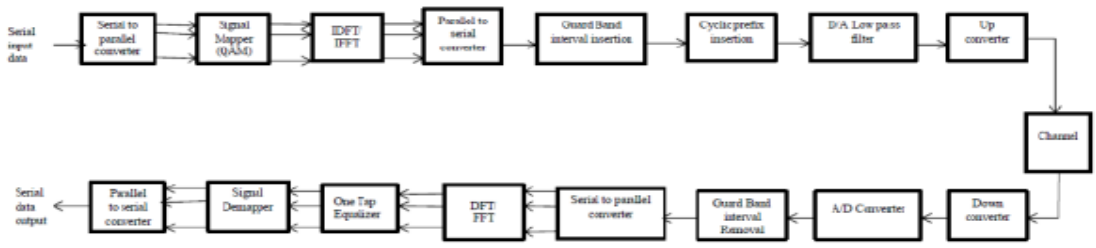

Fig. 1 Block diagram of FFT/DFT based OFDM System

Tb seconds is the length of the OFDM symbol. The inversely-Fourier signal is defined as Tb = NT, and the spectrum is also defined as time domain and time interval.

$$T_b = \frac{2\pi}{\Delta\omega} \Leftrightarrow \Delta\omega = \frac{2\pi}{T_b} = 2\pi\Delta f$$

The Fourier range for the Jth OFDM symbol is given by means of the equation (1)

$$U_j(\omega) = \sum_{p=0}^{N-1} U_j[p]\delta_c(w - p\Delta\omega)$$

In the Ofdm scheme, the cyclic prefix is used as an simple means of estimating channels by battling multipaths.

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Because of the length of the OFDM symbols, ISI is applied to the OFDM scheme to eliminate the interval of the ISI guard[3].

The power amplifier is used in the OFDM signal transmitter close to the saturation region in order to achieve power output, and due to nonlinear features the different signal amplitudes are sensitive. Changes in this signal amplitude trigger ISI and high PAPR at the power amplifier. ISI increase the output of the BER and decrease it[11, 12]. Big PAPR requires an expensive wide range of dynamic analog to digital converters. The machine efficiency can be enhanced through a PAPR reduction without losing the BER.

IV. System Model

Combined with OFDM, MIMO is currently commonly used because of the best performance in terms of channel capacity, high data rates and good results in limited fading channels in frequencies. Therefore, the reliability of the connection also increases. The OFDM is able to convert the frequency-selective MIMO channel into flat frequency MIMO channels[8]. This is accomplished. This is also commonly used in future wireless broadband systems / communications. The cyclic prefix is a duplicate of the last part of the OFDM symbol added to the transmitted OFDM symbol. It is 0.25% of the symbol of the OFDM. We might assume that a quarter of the OFDM symbol is CP and attached to each OFDM symbol (cyclic prefix). The transmitter uses IFFT, and the receiver uses FFT to replace modulators and demodulators. This restricts the use of oscillator banks and stable demodulators. In addition, the complex information can not be transmitted as it is, so it is first transformed into an analog form performed by IFFT. It translates the signal to the time domain from the frequency domain. A symbols mapping that is nothing but modulation blocks takes place before IFFT operation.

Some of the most common modulation techniques such as BPSK, QPSK, QAM, PSK can be implemented. However, higher-order modulations that provide more power at a reduced cost of BER performance degradation are available. The pilot insertion is made after IFFT block and then added the CP (cyclic prefix). The accompanying Figure 2 displays the MIMO and OFDM network diagram. The network criterion can be implemented for any MIMO antenna configuration. More performance will be, the efficiency will be greater and the transceiver architecture will become more computationally complex. The numerical complexity is increased in the case of channel estimation.

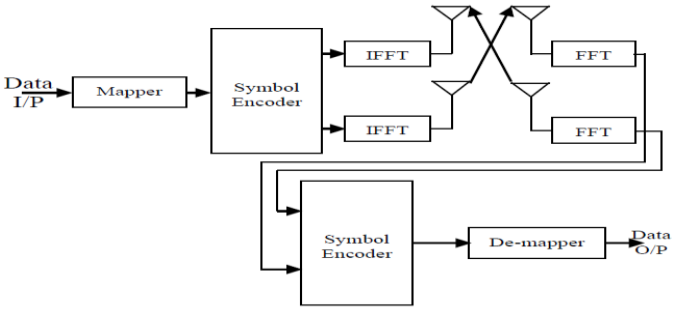

Fig. 2. MIMO-OFDM system model

The signal obtained by the jth antenna can be seen as

$$R_j[n.k] = \sum H_{ij}[n,k]\, X_i\,[n,k] + W[n,k]$$

In H, X is the origin, while W is noise with zero average and variance. If H is the origin signal. In addition, bi[n, k] is the antenna, nth time slot and kth sub-channel index OFDM transmitting data node.

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Here I and j have applied to the index of the antennas and the index of the antennas.

Antennas are obtained in MIMO-OFDM [10] with NR and antennas transmitted by NT can be provided:

$$\begin{bmatrix} Z_1 \\ Z_2 \\ \vdots \\ Z_N \end{bmatrix} = \begin{bmatrix} H_{1,1} & H_{1,2} & \cdots & H_{1,NT} \\ H_{2,1} & H_{2,2} & \cdots & H_{2,,NT} \\ \vdots & \vdots & \ddots & \vdots \\ H_{NR,1} & H_{NR,2} & \cdots & H_{NR,NT} \end{bmatrix} \begin{bmatrix} A_1 \\ A_2 \\ \vdots \\ A_{NT} \end{bmatrix} + \begin{bmatrix} M_1 \\ M_2 \\ \vdots \\ M_{NT} \end{bmatrix}$$

If Z is the O / P data vector, H is the channel matrix, A is the I / P data vector, and M is the vector of noise. The AWGN channel is the wireless internet. If the signal has been received, the CP is removed and the pilots are removed from the received main signal. After this, the signal in the time domain can be reconverted again by using FFT from the transmitted signal to the frequency domain.

Papr Reduction Technique

The literature includes a variety of PAPR reduction strategies. In theory, these strategies are classified into four categories:

•Signal Distortion.
• Coding Methods,
• Probabilistic (Scrambling) Techniques
• Pre-distortion Methods.

Each approach is cumbersome and worthwhile. The PAPR reduction is often paired with other variables such as bandwidth, computational complexity, average capacity, etc. The following would be an optimal PAPR reduction technique:

• High ability of PAPR decrease with hardly any hurtful symptoms, for example, in-band twisting and out-of-band radiation.
• Low usage intricacy: Due to high execution and computational unpredictability, the postponement in transmission expands which lessens information rate.
• Low normal force: any expansion in normal force requires a bigger direct activity district in HPA and in this manner bringing about the debasement of BER execution.
• No data transfer capacity development: The transmission capacity is a costlier asset for any remote correspondence framework. Along these lines, it is required to diminish PAPR without expanding the transmission capacity of the transmitted sign. The transmission capacity extension straightforwardly brings about the information code rate misfortune because of side data. In this way, the misfortune in data transmission because of side data ought to be maintained a strategic distance from or if nothing else be kept negligible.

V. Expected Results

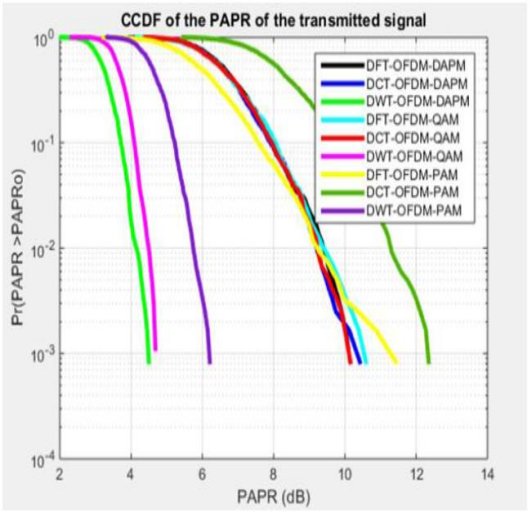

Fig. 3 PAPR and CCDF performances by using different transforms and modulation techniques

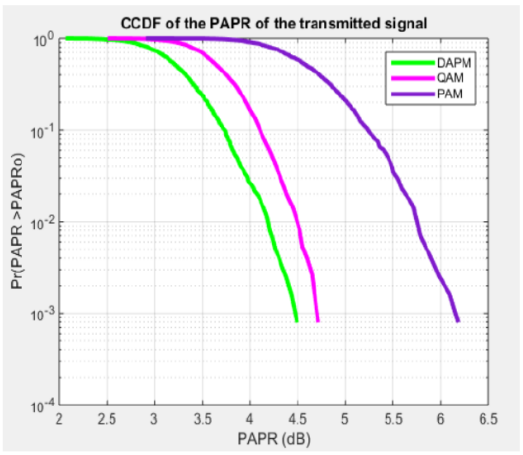

Fig. 4 PAPR and CCDF performances by using different modulation techniques using DWT

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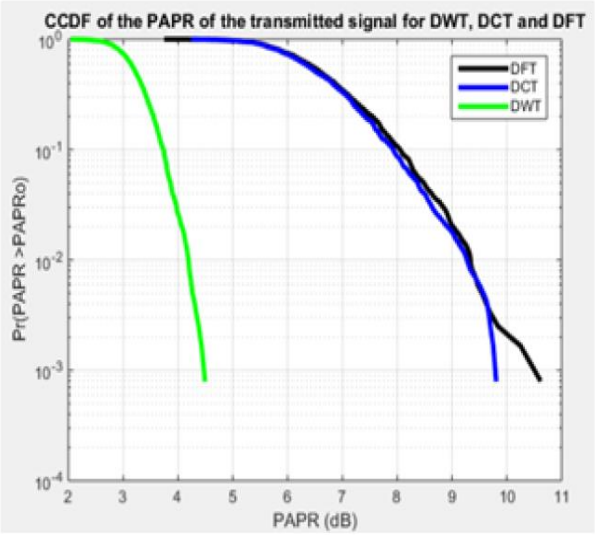

Fig. 5 PAPR and CCDF performances by using different transforms

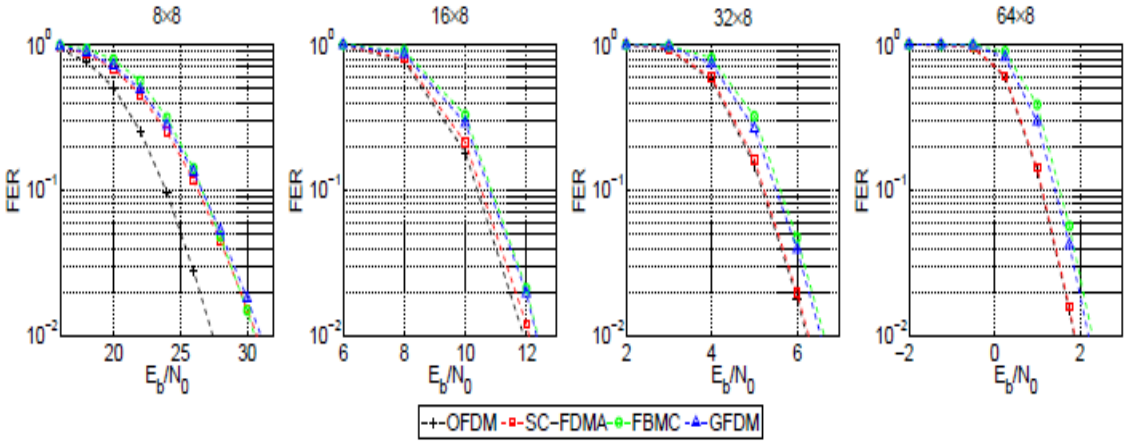

Fig. 6. Frame error-rate (FER) comparison between the considered waveforms. OFDM achieves the best FER performance; the gap to SC-FDMA, FBMC, and GFDM decreases for large BS-to-user antenna ratios.

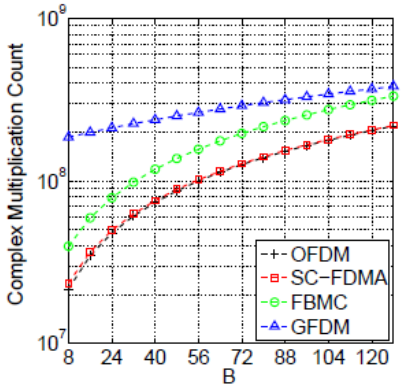

Fig. 7. Number of complex-valued multiplications for U = 8 user terminals. OFDM and SC-FDMA exhibit significantly lower complexity than FBMC and GFDM, especially for small BS-to-user antenna ratios.

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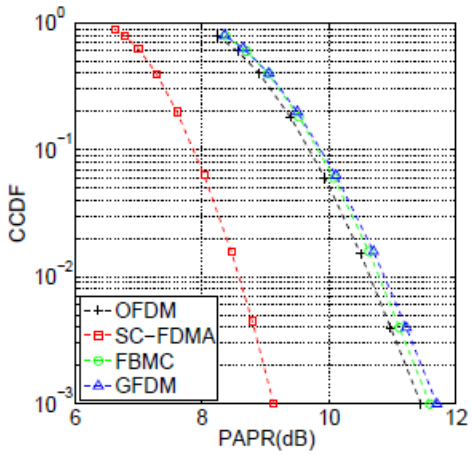

Fig. 8. PAPR Comparison between the considered waveforms. SC-FDMAexhibits the lowest linearity requirements, whereas OFDM only slightlyoutperforms GFDM and FBMC.

VI. Conclusion

The overall objective of this research is to implement a transceiver architecture for Filter Bank Multicarrier (FBMC) on the hardware of FPGA and to highlight some aspects of physical layer for future communication systems. Various modulation methods such as FBMC and OFDM systems have been extensively studied to achieve the desired goals. For the STBC MIMO-OFDM 5 G, a broad-based approach was suggested, called PTS, to joint optimize the PAPR for both the actual and the imaginary components. A strong PAPR is chosen for transmission between the two antennas. In terms of simulation performance and computational complexity, the proposed approach works well.

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