Numerical Simulation and Analysis of Peak Average and Power Ratio in FBMC 5G Communication System

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Abstract— Recently, as an alternative to Orthogonal Frequency Division Multiplexing (OFDM), Filter Bank Multi-Carrier (FBMC) has attracted great interest. Compared to OFDM, FBMC plans to increase frequency efficiency and low out-of-band (OOB) emissions. However, FBMC still encounters high position peak-to-average power ratio (PAPR) in OFDM systems. Some OFDM-based PAPR reduction techniques have adopted the FBMC system. In this paper, the proposed new FBMC system for PAPR reduction uses phase reordering (PR) and improved PR (MPR) techniques for OFDM systems based on its evolution. Unlike SC-FDMA (Single Carrier Frequency Division) multiple access, only DFT (Discrete Fourier Transform) spread spectrum and FBMC-OQAM (filter bank multi-carrier and offset quadrature amplitude modulation) are combined to cause only margin The PAPR (peak average) power ratio is reduced. Using the single carrier effect of DFT propagation, the IQ coefficient condition of each subcarrier is special (the corresponding quadrature phase channel is satisfied accordingly. To further increase the number of PAPRs, we generate DFT extension and ITSM conditional waveforms in FBMC and select the lowest peak power. Waveforms. Even if there are multiple candidate generations, the main calculation parts such as DFTShare and IDFT are executed only once, unlike the traditional SI (side information) based PAPR reduction procedure.

Keywords-FBMC,PAPR, OFDM, PSNR, BER,DFT.

I. Introduction

The "orthogonal" portion of the OFDM name describes the mathematical relationship between the frequencies of the carriers in the system. In a conventional FDM system, many carriers are spaced apart in such a way that signals can be received using conventional filters and demodulators. In such a receiver, a guard band must be introduced between different carriers, and adding these guard bands in the frequency domain results in a decrease in spectral efficiency. However, the carriers can be arranged in the OFDM signal such that the sidebands of the individual carriers are covered and the signals can be received without any adjacent carrier interference. In order to maintain this, the carrier must have orthogonal characteristics. The receiver behaves as a set of demodulators that downconvert each carrier to DC and then unify the resulting signal over the symbol period to recover the original data. If all other carriers break down to a frequency having an integer number of periods in the symbol period (t) in the time domain, the integration process results in a zero contribution from all of these carriers. Thus, if the carrier is separated by a multiple of 1/t, the carriers are linearly independent (ie, orthogonal).

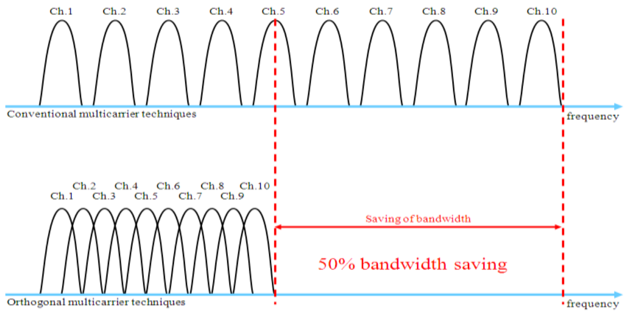

Fig:1. Frequency spectrum FDM Vs OFDM

Orthogonal Frequency Division Multiplexing (OFDM) is a multi-carrier modulation scheme in which the frequency of subcarriers is devil related. In other words, a multi-carrier modulation scheme equipped with orthogonal subcarriers is called OFDM. Let X = k to n-1 be the complex symbol set to be broadcast by multi-carrier modulation, and the continuous time domain MCM signal can be expressed as

$$x(t) = \sum_{k=0}^{N-1} Xk\ exp(j2\pi f kt) \quad \text{for } 0 \le t \le T_s$$
$$= \sum_{k=0}^{N-1} Xk\varphi k\ (t) \quad \text{for } 0 \le t \le T_s$$

where $f_k = f_o + k\Delta f$ and

$$\varphi_k(t) = \begin{cases} exp(j2\pi f_k t) & 0 \le t \le T_s \\ 0 & \text{otherwise} \end{cases}$$

For k = 0,1,2 ... N -1. If TsΔf = 1, the subcarriers become orthogonal, and this modulation scheme is referred to as OFDM, where Ts and Δf are referred to as OFDM symbol duration and subcarrier frequency spacing, respectively. In the case of orthogonal subcarriers, x(t) represents a time domain OFDM signal. The orthogonality between subcarriers can be viewed in the time domain, as shown in Figure 3.5. Each curve represents a time domain view of the waves of the subcarriers. As shown in Figure 3.5, there is an integer number of cycles per subcarrier in a single OFDM symbol duration.

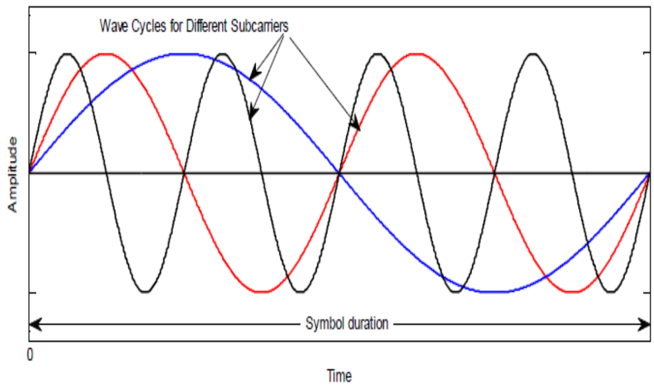

Fig 2.Time domain representation of the signal waveforms to show orthogonality among the subcarriers

Because of the orthogonality condition, we have

$$1/T_s \int_0^{Ts} \varphi k(t)\ \varphi j * (t)\ dt$$
$$1/T_s \int_0^{Ts} ej2\pi(fk - fl)\ t\ dt$$
$$= \delta\ [k-l]$$

Equation shows that $\varphi_k(t)$ for k=0 to N-1 is a set of orthogonal functions. Using this property the OFDM signal can be demodulated as

$$= \quad 1/Ts \int_0^{Ts} x(t)ej2\pi fk\ t\ dt$$
$$= \quad 1/Ts \int_0^{Ts} \left(\sum_{l=0}^{N-1} x(t)\varphi k(t)\right) \varphi j * (t)\ dt$$
$$= \sum_{l=0}^{N-1} x\ l\ \delta\ [k-l]$$
$$= x_k$$

II. FBMC (FILTER BANK MULTI-CARRIER)

The FBMC modulation scheme is a wide range of multi-carrier schemes. Subchannel modulation is performed by IFFT - similar to an OFDM system, and then a specially designed prototype filter is filtered through each subchannel. Various filters are available in the literature, which can be adapted to FBMC [11].

The key role of this filter is that it has a positive impact on the spectral characteristics of the transmitted signal. This section first introduces the block diagram of the FBMC transmitter. Descriptive statistics and spectral indicators study modulated signals. A prototype filter using a pulse in FBMC modulation applies the response of p0 to the subcarriers. These filters conform to the Nyquist criterion. Because the signal will have better spectral efficiency than the OFDM signal. Filter Bank Multi-Carrier (FBMC) has been added to systems such as cognitive radio and opportunistic dynamic spectrum access. Most likely to be considered a viable alternative to Orthogonal Frequency Division Multiplexing (OFDM). FBMC was introduced [1] as an alternative to OFDM and improved spectral efficiency and low (OOB) radiation. A good local waveform supply flexibly uses resources and provides help in two domains to increase computational complexity. However, complexity can be greatly reduced by using a multiphase implementation [2]. Although FBMC is superior to OFDM, FBMC systems also have higher major drawbacks. The peak-to-average power ratio (PAPR) of the transmitted signal. Due to the overlapping structure of the FBMC signals, PAPRC cannot directly use the reduction technique of the OFDM system. FBMC system. Several conventional OFDMAdopt PAPR reduction techniques (eg [3], [4]) FBMC systems. Several research focuses on reducing the PAPR of the FBMC system [5] - [8]. FBMC is introduced in the reduced PAPRFBMC technique [9] based on active constellation expansion. Both PTS [6] and SLM [7], but they introduce a high PAPR to reduce the complexity of the system, may require auxiliary information dissemination. In [8], based on the PAPR reduction scheme.

system design

In the transmitter, the binary information is first encoded using a convolutional encoder and then interleaved. The bits are then mapped using a complex modulation word A, where each symbol X represents M bits. Using offset-QAM modulation, the sum (1) portion of the real (R) complex modulation symbol X is transmitted with a time offset of half symbols. Finally, before transmission, the overlapping symbols are such that they can be separated in the receiver. The CP is not used in the FBMC system to maintain the orthogonality of the subcarriers. The discrete modulated baseband signals [n] of the FBMC may be represented based on their complex modulation symbols Xm [k] on the kth subcarrier.

$$[n] = \sum_{m=-\infty}^{\infty} \sum_{k=0}^{N-1} \left(\theta_k \Re X_m[k] po[n - mN] + \theta_K + 1\Im\{X_m[k]\} po\left[n - mN - \frac{n}{2}\right] e^{jk(n-mN)\frac{2\pi}{n}} \right)$$

A block diagram of the FBMC transmitter can be seen in Figure 1. The bit stream b is encoded into the encoded bit stream c, and then the bits are mapped to the complex symbols according to the modulation letter A. Finally, the polymorphic decomposition of equation (1) and the modulation prototype filter for the real and imaginary parts is effectively implemented using the aIFFT calculation. The two output signals are time-interleaved and added. In order to properly design the analog circuit of the transceiver chain, it is necessary to have an in-depth understanding of the statistical characteristics of the transmitted signal.

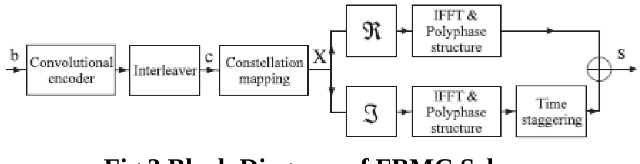

Fig 3.Block Diagram of FBMC Scheme

In order to properly design the analog circuit of the transceiver chain, it is necessary to have an in-depth understanding of the statistical characteristics of the transmitted signal. This type of research is especially important in the case of designing power amplifiers that must operate in an efficient manner. A simple technique for describing the dynamics of the transmitted signal s [n] is to calculate the PAPR defined as

$$\gamma_1 = \frac{max\{|s[n]|^2\}}{E\{|s[n]|^2\}}$$

where |s[n]| is the amplitude of the transmission signaland E{.} is the expectation value. The PAPR in dB isdefined as:

$$PAPR(s[n])dB = 10log\_10\ (\gamma_1)$$

For FBMC, the complementary cumulative density function (CCDF) of PAPR as a function of the number of subcarriers can be seen in Figure 2. It can be seen that as the number of subcarriers increases, the PAPR also increases similarly to OFDM.

In order to statistically describe the probability density function of the FBMC signal, the kurtosis of γ2 as a random variable ξ will be employed in the following discussion. The parameter γ2 of ξ is usually defined as

$$\gamma_2 = \frac{E\{\xi^4\}}{[E\{\xi^2\}]^2} - 3$$

It can be observed that γ2 quickly converges to zero with an increase in N (corresponding to the central limit theorem). This means that as the number of subcarriers increases, the FBMC signal is also converted to a Gaussian distribution.
The non-linearity present in the transceiver chain - especially caused by the amplifier - can severely degrade the advantageous characteristics of the low ACLR of the FBMC signal, as shown in [2].

III. SIMULATION & RESULT

In this work, we have simulated the simulation, considering the Wimax standard, where one RB represents 14 subcarriers on two OFDM symbols, containing 4 pilots and 24 data symbols. We have considered a 10 MHz system with a total of 60 RBs. The size of the OFDM block is considered to be 1024, including data subcarriers with QPSK modulation and 92 guard subcarriers at each end of the band. As will be noted, the MIMO transmit antenna is Mt, = 1, 2 or 4. A total of 10,000 OFDM blocks are randomly generated to generate a CCDF curve. For each block, a random complex fading channel is generated and the beamforming matrix is selected as the right singular vector of these channel matrices. We first compare the MIMO-OFDM scheme with the pure (DFT extended) FBMC and the previous DFT. - An extension based on simulated PAPR results. Figure 7 shows the CCDF curve for PAPR for a scheme in which OQPSK is compared with N = 128, OQPSK and N = 64 and 16 OQAM (N = 128). Compared to MIMO-OFDM systems, the PAPR CCDF curve of DFT Spread-FBMC shows better results.

Table- 1(PAPR Calculation OFDM)

Iteration	PAPR (MIMO-OFDM)
1	1.043113e+001
2	8.399582e+000
3	9.407558e+000
4	8.449497e+000
5	8.077563e+000
6	9.015796e+000
7	8.895236e+000
8	1.007338e+001
9	9.197113e+000
10	9.601901e+000

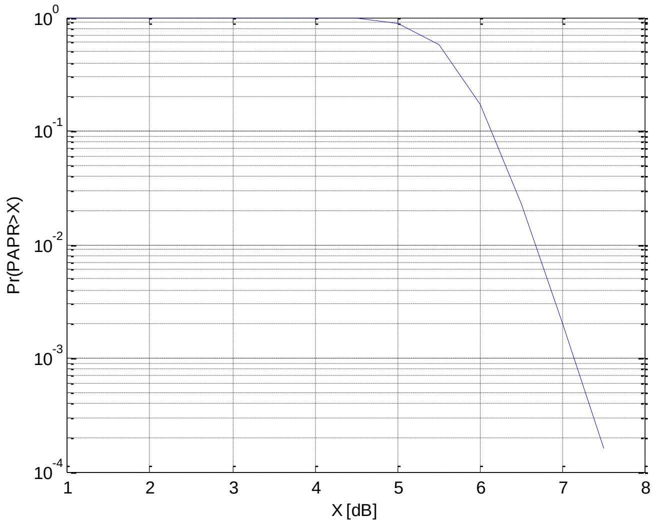

Fig 4. PAPR of FBMC Scheme

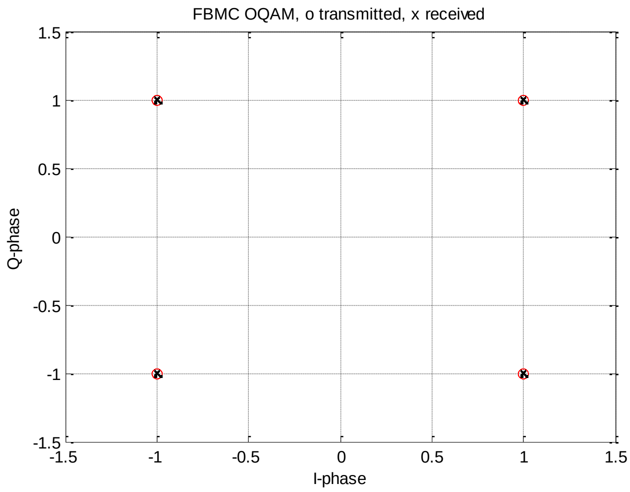

Fig 4. Modulation and Demodulation Operation

IV. CONCLUSION

In this paper, we propose a low-PAPR FBMC scheme and demonstrate its superior performance compared to existing PAPR reduction schemes in terms of PAPR reduction gain, computational complexity overhead, and SI overhead. We first derive the MIMO OFDM system for analysis. Calculating the PAPR value and comparing it with the FBMC scheme, it was found that FBMC performed well in PAPR, making it a suitable candidate for potential modulation schemes in 5G systems.

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