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Resource Allocation of Power in FBMC based 5G Networks using Fuzzy Rule Base System and Wavelet Transform

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ABSTRACT

Resource Allocation is necessary for better power allocation in 5G system and better spectral efficiency. Filter Bank Multicarrier (FBMC) is a Multicarrier technique that is used in 5G communication system. FBMC supersede Orthogonal Frequency Division Multiplexing (OFDM) as the Spectral Efficiency of FBMC ameliorate as compared to OFDM because of having FILTER instead of cyclic prefix. However power consumption is more in FBMC that can be reduced using FRBS (Fuzzy Rule Base System). Also Wavelet transform FBMC have better spectral efficiency but the power consumption is more which can be reduced by using various methods such as clipping method or tail end method.

Keywords: OFDM, FBMC, BEP, FIR FILTER, MCM

I INTRODUCTION

Due to advanced technology it has become important in 5G communication system to have better resource allocation that are performed in terms of power allocation and by increasing the spectral efficiency. Also it is done by increasing the data rate[1]. In 5G communication system the power allocation can be done by using various algorithms such as GA (Genetic-Algorithm) and PSO (Particle Swarm Optimization). In Genetic algorithm only one value will be localized that is one value will reach to the fittest possible value while as in PSO the power allocation is done globally that is all the values reach to the fittest value. Also in 5G communication system the spectral efficiency can be increased by using FBMC instead of OFDM used in 4G communication system. In FBMC filters are used instead of cyclic prefix which increases the spectral efficiency of FBMC as the bandwidth requirement in cyclic prefix is more that reduces the spectral efficiency in FBMC.

Also the wavelet FBMC is simulated which increases the spectral efficiency as compared to FFT-FBMC. The modulation used in DWT-FBMC is m-array QAM or $\sqrt{m}$ –PAM

II SYSTEM MODEL

Initially a system model considered is OFDM system with a time invariant channel and an assumption is made that the complete CSI is known at the receiver.

The frequency domain representation of system is given

$$r_k = h_k P_k X_k + Z_k ; k = 1,2,3...N. \qquad (1)$$

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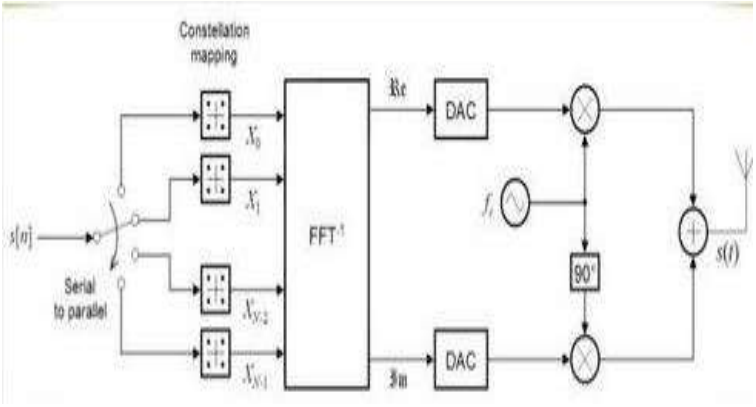

Figure 1 System Model

Its assumed k[th] subcarrier is transmitted over Rayleigh fading channel and with different amount of fading independent of each other. A simulation is performed and an analysis of BEP is done.

FBMC is simulated using HERMITE filter and BER performance is analyzed.

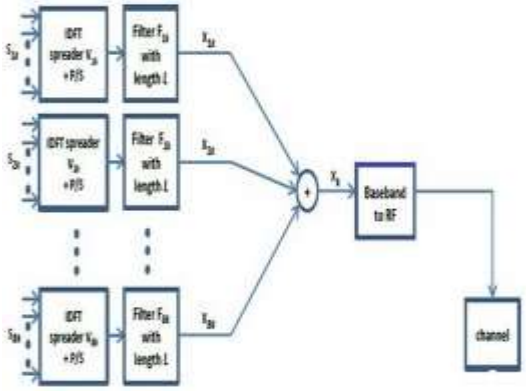

Fig 2 FBMC TRANSMITTER

In FBMC, one tap or two tap equalizer is used consisting of FIR (Hermite) filter which is localized in time and frequency. Such filter is orthogonal at TF=2.Thus the time and the frequency spacing is reduced by factor of 2 leading to TF=0.5, however this causes ISI which can be reduced using phase shifters.

Bit Error Probability

If y and h is zero mean correlated ,Guassian random variables, then BEP calculated can be given by Cumulative Distribution Function [3] expressed as

$BEP_{L,k}$

$$\frac{1}{\log_2 A}\sum_{p=1}^{\log_2|A|}\frac{1}{|A|}\sum_{J=1}^{|A|}P_r\left\{x_{l,k}=\widehat{a_i}(x_{l,k}=a_j\right\} \quad (2)$$

Set A={a_1,.....a$|A|$} represents symbol alphabet and every symbol gets mapped to unique bit sequence of size $\log_2 A$.

The SNR calculated can be expressed as

$$SNR=\frac{p_x^{OFDM}}{P_n}=\frac{p_X^{FBMC}}{\frac{1}{2}p_n} \quad (12)$$

It can be seen from the equation the power consumed in FBMC is half the power consumed in OFDM in the presence of noise. After analyzing the BER performance. PSO algorithm is used to allocate the power for each user. Also its compared with the water-filling algorithm that shows PSO outperforms better than water-filling algorithm. Spectral efficiency of DWT-FBMC and is compared with FFT-FBMC

III SIMULATION RESULTS

Simulation is performed to have spectral efficiency.

Simulation Parameters (Table 1)

The result obtained in the paper using following parameters are given in table

Table 1: Parameters.

S. No.	Parameters	Values
1	No. of Subcarriers	52
2	Subcarrier spacing	15khz
3	Modulation	m-QAM,
4	Channel	AWGN
5	BER	10e-2,10e-3,10e-4,10e-5,10e-6, 10e-7
6	Equalizer	Hermite
7	Wavelet	Haar

IV RESULTS

Simulation of FFT-OFDM and FFT-FBMC is performed. Simulation result as shown in figure 3 show the BEP of OFDM system and is analyzed that when SNR is 27 db. BEP at that time is close to 0.9

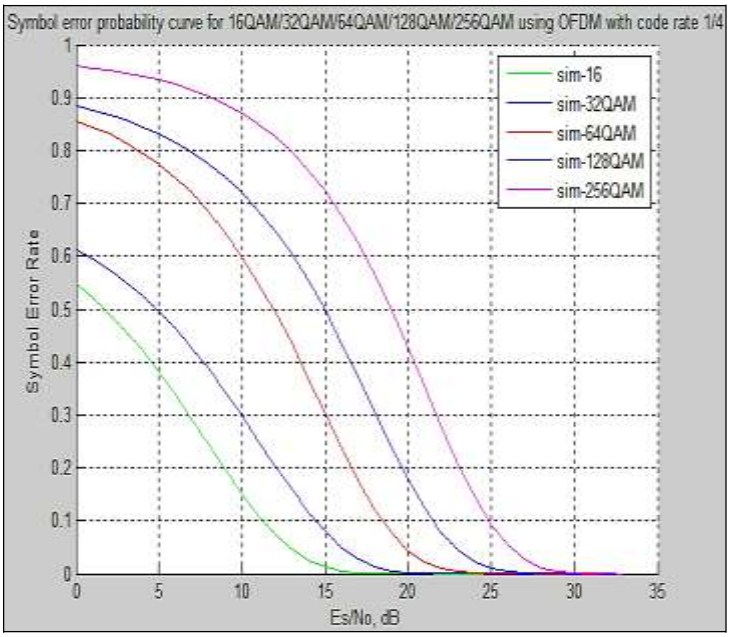

Fig 3 BEP for time invariant FFT OFDM system

Fig4 shows FBMC simulation and an analyses is made that when SNR is 27db. BEP is close to 0.6. Thus BEP in FFT-OFDM is more than FFT-FBMC.

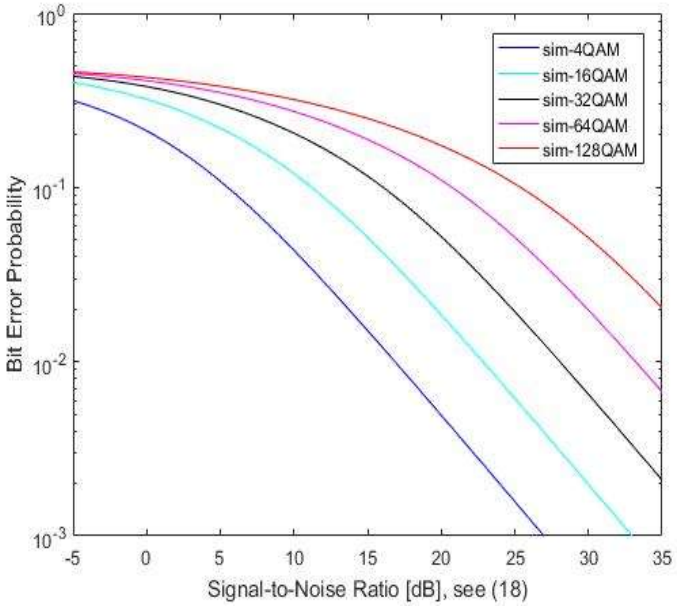

Figure 4 BEP for time-invariant FBMC

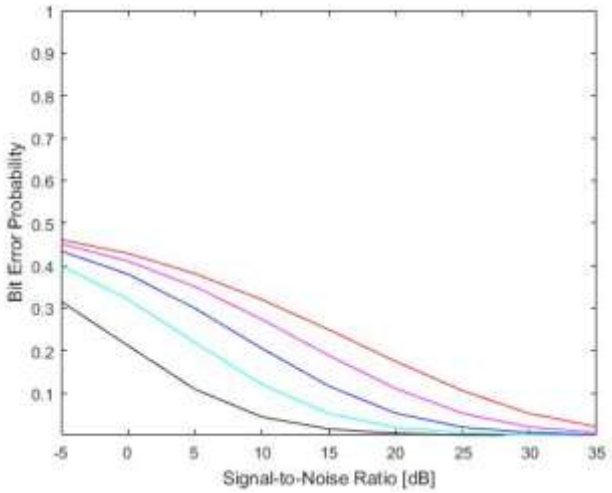

Figure 5 BEP using wavelet for FBMC system

Figure 5 represents simulation of wavelet FBMC and its seen from the simulation that when SNR is 27db. then BEP at that time is 0.4 which is less than FFT-OFDM and FFT-FBMC.

If the power spectral density of FFT-FBMC is compared with the Power spectral density of wavelet FBMC. After performing Simulation it is seen the side-lobes of FFT FBMC is less than wavelet FBMC .But the spectral density is better in DWT FBMC. However side-lobes can be reduced by different techniques such as clipping or tail end method

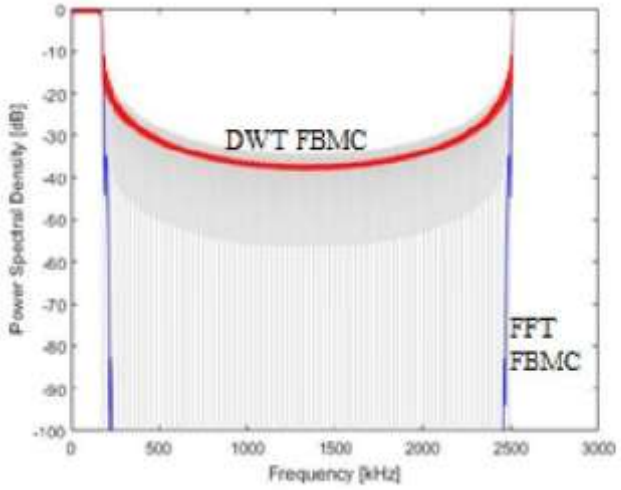

Figure 6 PSD of FFT-FBMC and DWT-FBMC

Algorithm used for power allocation is PSO. After simulating the FBMC and when PSO algorithm is used it shows that different users can use different power depending upon the channel condition as shown in figure 7

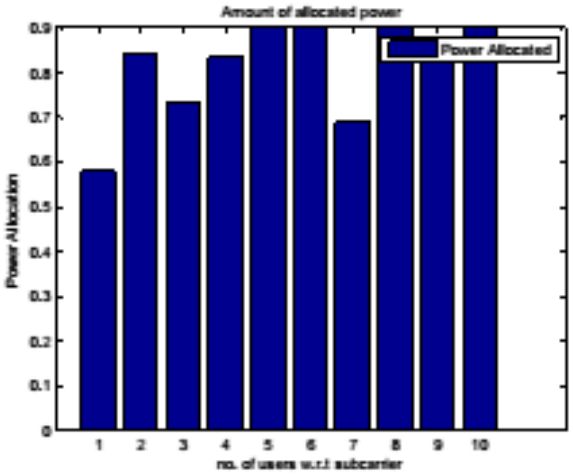

Figure7 Power allocation using PSO-Algorithm

Figure8 represents power allocation using water-filling algorithm and its seen that every user will allocate same power even if the channel condition is different. Thus the power consumption will be more in FBMC with water-Filling Algorithm.

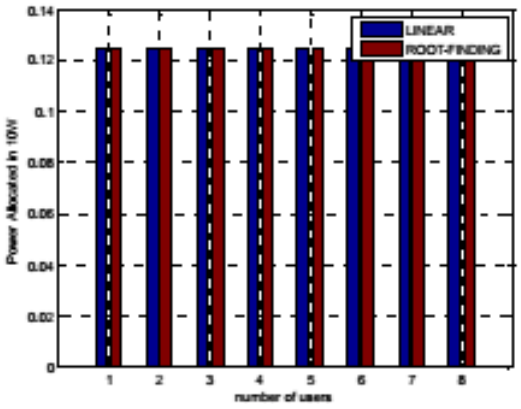

Figure8 Power allocation using water-filling Algorithm

V CONCLUSION

FBMC is the technique that is used in 5G communication systems instead of OFDM that is used in 4G because of having higher spectral efficiency which can further be increased by using wavelet FBMC. But the wavelet FBMC has maximum side lobes that can eliminate by tail end method. Resource allocation is also done by PSO algorithm and water-filling algorithm that optimize the power of FBMC system used in 5G communication system.

REFERENCES

1. Ng DWK, Lo ES, Schober R. Energy- Efficient Resource Allocation in Multiuser OFDM Systems with Wireless Information and Power Transfer. Proceedings of the IEEE Wireless Communications and

Networking Conference (WCNC-2013); 2013 Apr 7– 10; Shanghai, China.

2. R. Nissel and M. Rupp, "Enabling low-complexity MIMO in FBMCOQAM," in IEEE Globecom Workshops (GC Wkshps), 2016.
3. L. Rugini and P. Banelli, "BER of OFDM systems impaired by carrier frequency offset in multipath fading channels," IEEE Transactions on Wireless Communications, vol. 4, no. 5, pp. 2279–2288, 2005.
4. T. Wang, J. G. Proakis, E. Masry, and J. R. Zeidler, "Performance degradation of OFDM systems due to Doppler spreading," IEEE Transactions on Wireless Communications, vol. 5, no. 6, pp. 1422–143 2006.
5. H. G. Feichtinger and T. Strohmer, Gabor analysis and algorithms:Theory and applications. Springer Science & Business Media, 2012.
   [6] R. Nissel and M. Rupp, "On pilot-symbol aided channel estimation in FBMC-OQAM," in IEEE ICASSP, 2016.
6. R. J. Baxley, B. T. Walkenhorst, and G. Acosta-Marum, "Complex Gaussian ratio distribution with applications for error rate calculation in fading channels with imperfect CSI," in IEEE GLOBECOM, 2010.
   [8] R. Nissel and M. Rupp, "Bit error probability for pilot-symbol aided channel, Evans BL, et al. A low complexity algorithm for proportional resource allocation in OFDMA systems. Proceedings of the IEEE Workshop on Signal Processing Systems; 2004 Oct 13– 15; Austin, TX, USA.
7. 1. M. Russell and G. L. Stuber, "Interchannel interference analysis of OFDM in a mobile environment," in IEEE VTC, 1995, pp. 820–824. [10] H. Asplund, K. Larsson, and P. Okvist, "How typical is the "typical urban" channel model?" in IEEE VTC, 2008, pp. 340– Ng DWK, Lo ES, Schober R. Energy- Efficient Resource Allocation in Multiuser OFDM Systems with Wireless Information and Power Transfer. Proceedings of the IEEE Wireless Communications and Networking Conference (WCNC-2013); 2013 Apr 7– 10; Shanghai, China.
8. Reddy YB, Gajendar N, Taylor P, et al. Computationally Efficient Resource Allocation in OFDM Systems: Genetic Algorithm Approach. Proceedings of the 4th International Conference on Information Technology (ITNG'07); 2007 Apr 2–4, Las Vegas, NV. 36–41p.
9. Annauth RS, Rughooputh HCS. OFDM Systems Resource Allocation using Multi- Objective Particle Swarm Optimization. IJCNC. 2012; 4(4): 291–306p.
10. Atta-ur-Rahman, Qureshi IM, Muzaffar MZ. Adaptive Coding and Modulation for OFDM Systems using Product Codes and Fuzzy Rule Base System. IJCA. 2011; 35(4): 41–8p.
11. Atta-ur-Rahman, Qureshi IM, Malik AN. A Fuzzy Rule Base Assisted Adaptive Coding and Modulation Scheme for OFDM Systems. J Basic Appl Sci Res. 2012; 2(5): 4843–53p.
12. Kennedy J, Eberhart RC. Particle Swarm Optimization. Proceedings of IEEE Conference on Neural Networks; 2011 Nov 27–Dec 1; Perth, WA.
13. Atta-ur-Rahman, Qureshi TM, Malik AN. Adaptive Resource Allocation in OFDM Systems using GA and Fuzzy Rule Base System. World Applied Sciences Journal. 2012; 18(6): 836–44p.