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

\[
r_k = h_k P_k x_k + z_k \quad :k = 1,2,3...N.
\]  (1)
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.

**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

$$\text{BEP}_{L,k} = \frac{1}{\log_2 2} \sum_{p=1}^{\log_2 2} \frac{1}{|p|} \sum_{|f|}^{\log_2 2} P_r \left\{ x_{L,k} = \frac{a_i}{a_j} \right\}$$

(2)
Set $A = \{a_1, \ldots, a_{|A|}\}$ represents symbol alphabet and every symbol gets mapped to unique bit sequence of size $\log_2 A$.

The SNR calculated can be expressed as

$$\text{SNR} = \frac{P_{\text{OFDM}}}{P_n} = \frac{P_{\text{FBMC}}}{\frac{3}{2}P_n}$$  \hspace{1cm} (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 it's 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>
<thead>
<tr>
<th>S. No.</th>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No. of Subcarriers</td>
<td>52</td>
</tr>
<tr>
<td>2</td>
<td>Subcarrier spacing</td>
<td>15kHz</td>
</tr>
<tr>
<td>3</td>
<td>Modulation</td>
<td>m-QAM</td>
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<tr>
<td>4</td>
<td>Channel</td>
<td>AWGN</td>
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<tr>
<td>5</td>
<td>BER</td>
<td>$10e^{-2}, 10e^{-3}, 10e^{-4}, 10e^{-5}, 10e^{-6}, 10e^{-7}$</td>
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<tr>
<td>6</td>
<td>Equalizer</td>
<td>Hermite</td>
</tr>
<tr>
<td>7</td>
<td>Wavelet</td>
<td>Haar</td>
</tr>
</tbody>
</table>

### 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

Fig 4 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 represents simulation of wavelet FBMC and it’s 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.

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.
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