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Detection of Idle Spectrum using Cognitive Techniques for Advanced Waveforms

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ABSTRACT

Thus, this study makes use with and two-way relaying to improve these essential and paramount efficiencies, performance and strength criteria. The work starts with the current state of wireless transmissions, and then introduces cognitive radio and relaying. The simulation results shows that by using MIMO OFDM and Cognitive technology and advancements the efficiency, performance and effectiveness and efficiency of BER vs SNR can be significantly increases and It is also depicted and presented that when the number of primary users are more as compared to secondary users the quality of service and energy efficiency is increases. The outcome of this research work proved that with the increase of numbers of antennas at transmitter end of the system and the assignee, the throughput, efficiency of the system is increases and the interference is also reduces.

Keywords: *5G, Energy detector, CR, Multi-carrier waveform*

1. INTRODUCTION

In the year 1895, Marconi invented a radio which was used to transmit the signal from one place to another place without the use of wires for which he got the noble prize in the year 1909. Graham Bell and Charles Sumner Trainers invented a telephone in the year 1980 which was the beginning of telecommunication era [1]. The first commercial phone was designed and implemented in Bell Lab, USA in 1946. Analog frequency transmission scheme and high power transmitter were used in early mobile which limit the coverage up to 50Km due to which very few customers get the service with lots of constraint of spectrum. In order to achieve an efficient bandwidth, cellular model was introduced by Bell Lab which utilized the technique called frequency reuse to achieve an efficient bandwidth and power consumption was also reduced [2]. The first generation mobile phone also known as 1G was consisting of analog system accessing Frequency Division Multiple Access (FDMA) technique. Nordic Mobile Telephone (NMT), American Mobile Phone System (AMPS), Total Access Communication System (TACS) were the first generation mobiles [3]. Sensitive to interference, requirement of high power and its analog technique were few disadvantages of 1G mobile. One of the main reasons for failure of analog mobile was used of different standard by different countries which were incompatible [4]. To overcome the issues of 1G, Second generation (2G) mobile were introduced which used digital technology. Better spectrum utilization due to accessing of advanced modulation technique, high capacity, introduction of SMS, improved handoff, good signaling were few advantages of 2G MOBILE Communication System. Among several, most popular 2G mobile phone was GSM (Global system for mobile Communication) [5]. Primary GSM used 890-915 MHz for uplink and 935-960 MHz for downlink, Extended GSM used 890-915 MHz for uplink and 925-960 MHz for downlink, GSM1800 used 1710-1785 MHz for uplink and 1805-1880 MHz for downlink and GSM1900 used 1850-1910 MHz for uplink and 1930-1990 MHz for downlink. Due to rising demands from the industry and subscribers like high data rate lead development of Third generation (3G) mobile communication system. In 3G, CDMA is used as a modulation technique, where multiple users share the same channel with different code [6]. Hence, CDMA is considered as one of the secured communication. Inter Symbol Interference, Cross talk and high power consumption are the disadvantages in CDMA due to which OFDM is considered in fourth generation mobile communication system (4G).In the year 1971, Weinstein and Ebert introduced a new multi carrier technique whose set of modulator and demodulator was replaced by using a discrete Fourier transform (DFT). OFDM as a radio technique is widely used for high data-rate wireless communication system due to its better utilization of the spectrum and immune to fading of signals [7]. For instance, in OFDM, CP (Cyclic Prefix) is inserted between two symbols to eliminate ISI. However, CP results in wastage of bandwidth [8]. It has been estimated that by the year 2020 data consumption would have been increased by more than 30%. Hence, next generation mobile communication commonly known as 5G will need a new and improved technological core. OFDM cannot be considered adequate for this purpose due to the above mentioned disadvantages. A new modulation technique such as FBMC, are being explored and experimented upon in hopes that one of them may become a conceivable option for 5G wireless communication. FBMC is the most probable modulation techniques that have been able to exhibit not

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similar but better performance than OFDM. It does not insert a CP between the symbols, meaning the availability of extra bandwidth. It is an advanced version of OFDM, which uses a set of filters at both the transmitter and receiving end to provide better communication with more prudent bandwidth utilization [9]. However, the principle of OFDM and FBMC are same as both are multi carrier techniques. In multi carrier techniques, the resulting output is the addition of several subcarriers that leads to a condition where output instantaneous power becomes greater than the mean power of the model. In this scenario, the system suffers from high PAPR which considerably hampers the performance of the amplifier used in FBMC and OFDM. PAPR minimization techniques used in OFDM cannot be used for FBMC due to their overlapping structure. Therefore, many PAPR reduction techniques need to be investigated for FBMC [10]. The work presents the designing of an OFDM (Orthogonal Frequency Division Multiplexing) and FBMC (Filter Band Multi Carrier) modulation techniques. The proposed method consists of OFDM and FBMC prototype filters for transmitting and receiving the data symbols. Both of them are multicarrier technologies used to increase the performance of wireless communication system. BER (Bit Error Rate), PAPR (Peak Average Power Ratio), Capacity and energy detection spectrum sensing measurements were simulated and examined bands. The authors discussed and described the channel capacity of FBMC and OFDM integrated with cognitive radio. Result reveals that the capacity and gain of OFDM is better than FBMC [11]. Greedy suboptimal algorithm based FBMC cognitive radio performance is discussed and analyzed authors. The main aim of the proposed work was to efficiently utilize the bandwidth without causing any interference. The numerical results of BER and SNR were analyzed to reveals that performance of the OFDM was better than FBMC [12]. The authors evaluate the performance of QAM-FBMC and O-QAM FBMC and the effect of TO (Time offset) and CFO (Carrier Frequency Offset) is analyzed and computed. The output of the work reveals that the effect of ISI is greater for O-QAM FBMC because it includes two different filters whose orthogonally criteria is not satisfied. QAM-FBMC utilizes two types of filters whose orthogonally criteria are not satisfied which results in severe ISI. Overall, an outcome of the work reveals that QAM-FBMC performance is better for CFO but sensitive to as compared to O-QAM-FBMC [13]. The authors implemented FBMC to perform a simple synchronization to access the fragmented spectrum, which also reduces the physical channel signaling of the system. Additionally, the performance and capacity of OFDM and FBMC are analyzed and compared [14]. PAPR is considered as one of the most important issues in OFDM technique. It usually occurs when an amplifier used in OFDM swings from linear to non-linear region. In this work, ACE (Active Constellation Method is proposed to reduce the PAPR of the proposed system [15]. OFDM system is designed by using a vector base method. The PAPR is reduced by using a clipping technique. ISI reduction and detection was achieved by using an MMSE (minimum mean square error) equalizer [16]. One of the most challenging issues in a wireless communication system is to increase the capacity of the system. In this work, channel capacity of FBMC and OFDM integrated with cognitive radio is discussed and described. The Result reveals that the capacity and gain of FBMC is better than OFDM under perfect channel estimation [12].

2. SYSTEM MODEL

A random data is generated by using a Bernoulli binary generator which generates 1 and 0. The transmitter part of OFDM is implemented by using IFFT (Inverse Fast Fourier Transform) which converts the signal from the frequency domain to the time domain, CP which is inserted between OFDM symbols to reduce ISI. The OFDM signal is spread over an AWGN (Additive White Gaussian Noise).Likewise, the receiver is implemented by taking out the cyclic prefix, using FFT (Fast Fourier Transform). Finally the complex received signal is simplified and processed to the destination. A block of symbol is encoded by mean of FFT and transmitted parallel over a number of sub-channels. Cyclic prefix is inserted in every block of data and it is modulated. After the transmitter antenna the signals go through all the anomaly and hostility of the wireless channel. After a channel estimation is performed using a demodulated pilot, the received data are obtained by using the estimation. At this time channel decoding and de-interleaving is performed to recover the original signal free from any obstacle. Simulation parameters are given in table.1.

Table. 1. Simulation Parameters for OFDM & FBMC

OFDM	FBMC
Bandwidth= 4MHz FFT Size= 64 Subcarrier Spacing: 4MHz/64 Subcarriers = 64 CP= 17% of bandwidth is lost due to CP insertion. Filter = Not used	Bandwidth= 4MHz FFT Size=64 Subcarrier Spacing: 4MHz/64 Subcarriers= 64 CP = Not Used Filter = PHYDAS Filter Overlapping Factor K=4 Length of Filter = K*M-1

3. Simulation Results

The FBMC and OFDM subcarriers waveform are plotted for k= 1, 2, 3, 4, 5, 6 (K= overlapping Factor) are shown in Fig.2 and Fig.3. The FBMC and OFDM system outcome results in excellent subcarriers pulse shaping as compared to OFDM. Hence, Inter Symbol Interference (ISI) is not considered a huge problem in the fourth generation mobile system.

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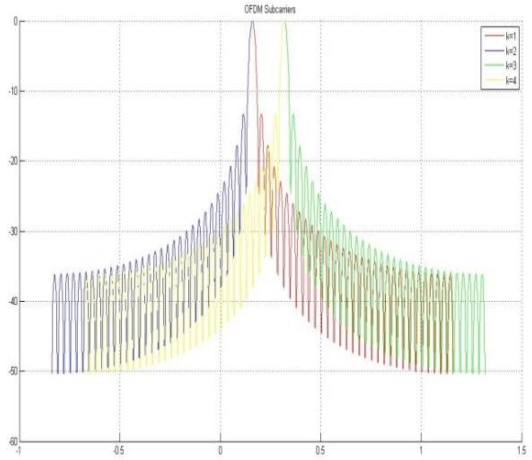

Figure 2. OFDM waveform

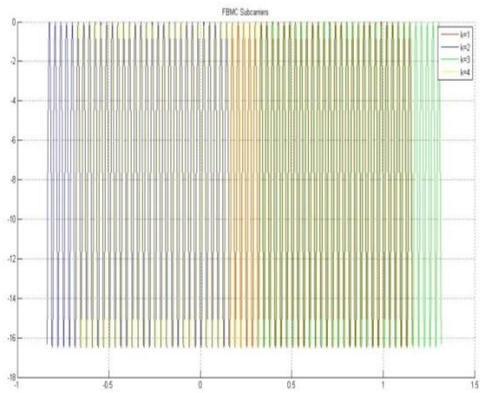

Figure 3. FBMC Waveform

The magnitude and phase response of OFDM and FBMC is shown in Fig.4. The response of FBMC is more compact as compared to OFDM. The compact response of FBMC will make it immune to noise and linear distortion whereas the OFDM system is susceptible to noise and interference.

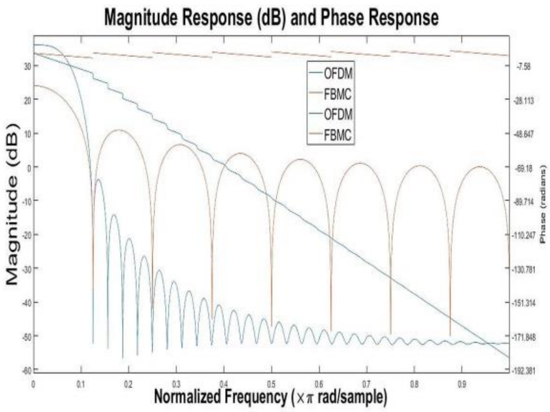

Figure 4. Phase Response

In Fig.5 BER performance of OFDM and FBMC for transmitting the symbols is presented. Referable to the inner noise in OFDM and use of CP, its BER measurement displays marginally differ from FBMC. A BER of OFDM is more as compared to FBMC. Overall, 34% efficiency in BER is achieved in FBMC. Hence, it proves that FBMC is a better modulation technique as compared to OFDM and no usage of cyclic prefix in FBMC makes it more preferred modulation scheme for fifth generation.

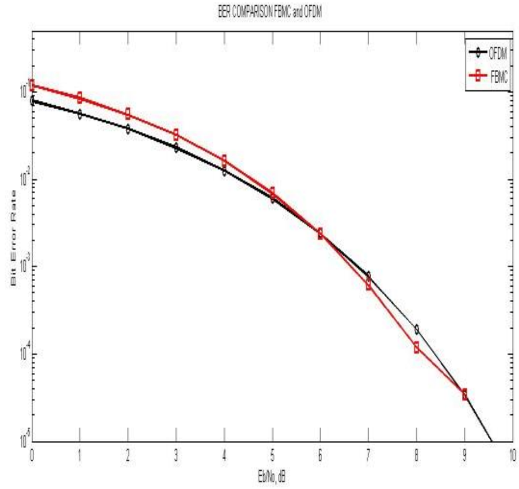

Figure 5. BER QAM

The Fig.6 represents a graph of probability of energy detection vs SNR. The probability of detection is low when the SNR is low and the probability of detection is high when the SNR is high. This means for efficient detection of the spectrum, the received power should be greater than noise power and power control algorithm is also needed. The proposed work, achieved a better performance as compared to the conventional model implemented.

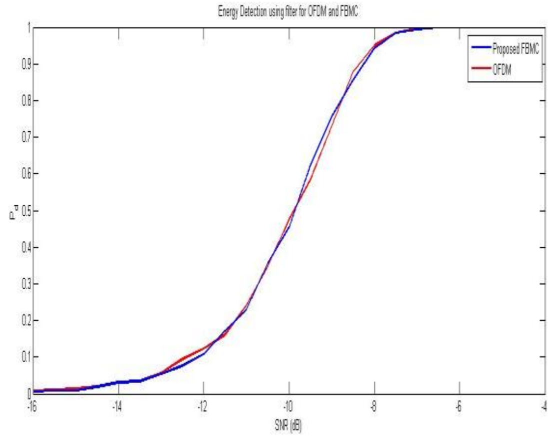

Figure 6. Ed vs SNR

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4. CONCLUSION

Though this study focused on restrictions of OFDM in current and forthcoming communication systems, the significance and desired structures of OFDM system cannot be ignored. The purpose is to highlight the point that OFDM, though extensively implemented in the current engineering, is not the best techniques in several next-generation communication systems, more often than not in cognitive radio networks and multiple accesses where FBMC is considered to be more promising. The demand for spectrum in wireless environment has increased substantially due to the widespread use of smart phones. We have proposed a FBMC which do not use CP results in utilization of bandwidth as compared to OFDM (11% of bandwidth is lost). Energy detection spectrum sensing (cognitive radio) technique is implemented which sense and share the spectrum to the unlicensed user to increase the performance of the network. Implementation and comparison multicarrier techniques (OFDM and FBMC) is also discussed and several parameters like bandwidth, PAPR, Capacity, BER, magnitude response of subcarriers, probability of detection and probability of false alarm is simulated and analyzed. It was observed that FBMC system provides a better spectrum utilization and improvement in transmission performance. FBMC has the drawback of high PAPR (Peak Average Power Ratio) in the cellular communication environment. In multi-carrier techniques, the resulting output is the addition of several subcarriers that leads to a condition where output instantaneous power becomes larger.

Future Scope

- Orthogonal Issue: Due to the structure and internal distortion, FBMC loses its orthogonally because of waveform overlapping nature in time domain.
- Packet Transmission: The performance of FBMC is excellent for short range packet transmission but it is unsuitable for long range packet transmission. Transmitting the information to a long range results in loss of orthogonally between the subcarriers.

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