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Cognitive Radio System Supremacy Channel Configuration

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Abstract

Utilization of unused spectrum in wireless communications is a revolutionary advancement known as cognitive radio that is initially allocated only to licensed services. Here, we propose a design for control channel in this network (cognitive radio network). Multi carrier spread spectrum is employed as a control channel in cognitive radio system. Among the types of control channel underlay/Overlay control channel is preferred. FBMC subcarrier is localized. Also, we propose a Blind channel estimation technique for control channel. Comparison between OFDM and FBMC based MC-SS is analyzed and suggested that FBMC is better. SNR and BER in MC-SS are calculated.

Keywords: OFDM, cognitive radio systems, FBMC, MC-SS.

1. Introduction

Spectrum utility is maximum with and without interference in cognitive radio technique. Cognitive radio system is one in which mutual interference among users are to be managed in order to enable the spectrum sharing effectively with the higher priority of licensed users. Cognitive radio is a wireless communication transceiver system that identifies the channels in the provided spectrum. Duplexing of channels, many transmissions and receptions will happen simultaneously in this system identifying the respective channel parameters and is called as dynamic spectrum management.

Cognitive radio is a promising technique which helps in enhancing the wireless spectrum utilization. Meanwhile the spectrum is allocated only to main terminals in a network; CR permits the other terminals to identify the spectrum. Also, automatically adjust transmission & reception parameters to access the same spectrum occasionally. We should

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keep in mind that the interference of licensed terminals are below the threshold. CR employs multicarrier method since the CR physical layer is flexible for occasional access. So, We are going for OFDM in the CR network.

There are two terminals in the CR system, one is the licensed terminals and the other is the secondary terminals. The prior objective of CR system is that both the primary and secondary terminals should productively make use of spectrum. Licensed terminals are given priority over the secondary user. Cognitive provide better bandwidth efficiency in spectrum utility. In a CR network, first of all we should identify free channels of the spectrum and share it without interference with the other users. Identifying licensed terminals is a path to identify free channels in the spectrum. Three different types of spectrum sensing techniques are discussed below:

1. CR should have the ability to identify a signal from licensed terminal is present in the spectrum or not. Different methods are proposed here for this purpose.

a. Matched filter detection.

b. Energy detection.

c. Cyclostationary-feature detection.

2. Cooperative detection - Refers to spectrum information from multiple cognitive-radio users which are included for licensed terminal detection.

3. Interference-based detection - Refers to sensing the spectrum without any interference between the users.

Controlling of power in spectrum utilization is occasional. Channel sharing CR is employed in identifying threshold value of SNR while allocating the channel and force power restriction due to interference to protect licensed terminals. Therefore, Capacity of the system is improvised by knowing about utilization of power and identifying the unused spectrum which is proposed here.

Sensing the unused spectrum in a better way to satisfy the needs of terminals without creating the interference to licensed terminals. CR will take care of the best unused spectrum band to provide quality service to the end terminals. Therefore, some functionalities are needed for CR. They are Spectrum decision and Spectrum analysis.

Cognitive radio are of two kinds. One is Full cognitive radio that is responsible for each component identified by a network is examined. On the other hand, we have Spectrum sensing cognitive radio where the spectrum alone is examined.

Based on the unused spectrum the other kinds of CR are taken into consideration. Licensed terminals utilizes the licensed band. On the other hand, unused parts of the spectrum is utilized by unlicensed terminals.Spectrum mobility is the one where a CR

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terminal moves to the other frequency channels. Spectrum sharing permits CR network to use the same spectrum of the licensed terminals.

In Spectrum sensing and sharing, first of all CR users identify the allocated spectrum to the licensed terminals to know its state. Then based on this information, CR terminals uses strategy for transmission.

Every terminal should have the capability to sense unused parts of the spectrum and share the data with other terminals efficiently. A two way link is established for the transfer of data is called as control channel. The main advantages of this control channel is that it can be easily installed, interference with licensed terminals is minimized and in different channel

considerations it performs at its best. It is a very reliable one using Spread spectrum technique which allows a channel behind licensed terminal noise temperature. We have many spread spectrum techniques, among them we choose MC-SS is mostly used here

2. Channel Configuration

Licensed channel having a narrowband signal is employed to transfer control channel signals. Also it is called as out-of-band control channel. Since, frequency band is passed through a control channel without overlapping with licensed terminal's frequency band. Cognitive radio network having nodes might automatically initiate CCC in temporary method. Here, it transmits information and identifies the receiving node by hopping from one frequency band to another upto in identifying a common control channel in the network to communicate. The control channel facilitates the following operations

- Handshake of Transmitter –receiver
- Identifying the neighbour
- Variation in the topology & exchange of routing data.
- Exchange spectrum sensing data and primary user's activity.
- Avoid hidden terminal problem.
- The types of control channels are as follows:
- Dedicated Control Channel (DCC).
- Common Control Channel (CCC).
- Underlay Control Channel (UCC).

Here, common control channel adopts spread spectrum technique. Also, we use the whole

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spectrum including licensed terminal activities. The transmitted power is maintained in comparison to the noise temperature which are not identified by the licensed terminals.

Control channel is confirmed in DCC. It is very simple and flexible, so it is employed. Difficult thing is to have always a dedicated channel. Therefore, we propose many techniques in initiating a control channel in a spread spectrum technique. CCC is a best technique and researched well for this purpose.

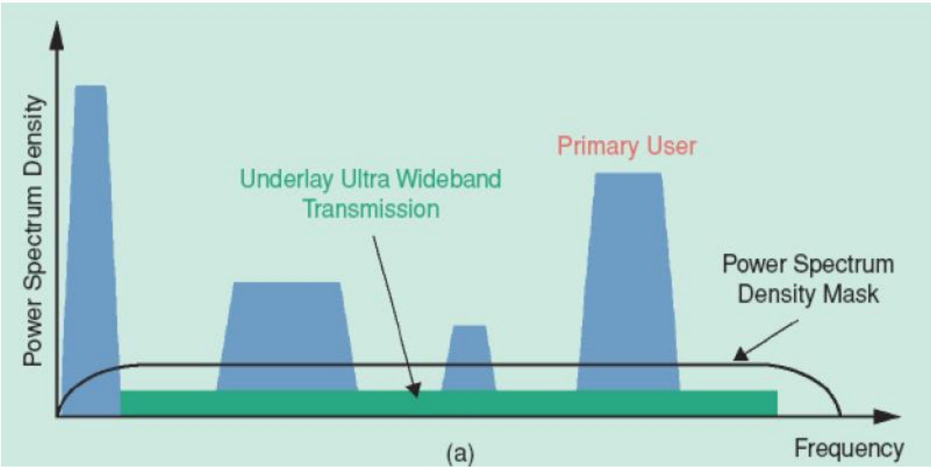

Figure: 1 Underlay Control Channel

The main purpose is to transmit information to the end terminals by hopping from one frequency band to another up to in identifying a common control channel in the network to communicate. There are two disadvantages in this technique, one is hidden terminal problem and the other is time to rendezvous. To overcome the above said weaknesses, it is suggested to use SS methods in UCC. Here, the control channel uses the whole spectrum with low power transmission. Hence the licensed terminals which are closer identifies the transmission in comparison with the noise temperature.

By the way the whole spectrum is utilized with lower contact of PUs. Control channel impact on the PUs is decreased by employing OQAM-SS UCC. Automatically choosing the frequency bands might be identified as additional information in comparison with DS-SS and FH-SS. So, OQAM-SS UCC is a good option for cognitive radio networks.

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3. Proposed Multi Carrier Spread Spectrum

Multicarrier modulation is a best technique in which the spectrum is divided into small frequency channels, each having a distinct carrier. Multicarrier communication technology is a best option to identify unused parts of the spectrum. Multicarrier transceiver is an important technique to identify the basic properties of a cognitive radio network in which SU automatically jam the unused spectrum. Firstly, the transmitter should identify the frequency band(unused spectrum). On the other hand, receiver must have the ability to limit the frequency band interference on the channel. Among different multicarrier technique, multicarrier modulation along with Filter bank is replaced with OFDM.

Multicarrier modulation with Filter bank is a spread spectrum technique in which it has a transmitter filter bank.The transmitter input consists of data bits which are passed through the filter with g(t). it is converted from TxFB to RF. Filter bank consists of various values that are processed in the frequency domain. band limited signal x(t) is obtained from subcarrier frequencies.

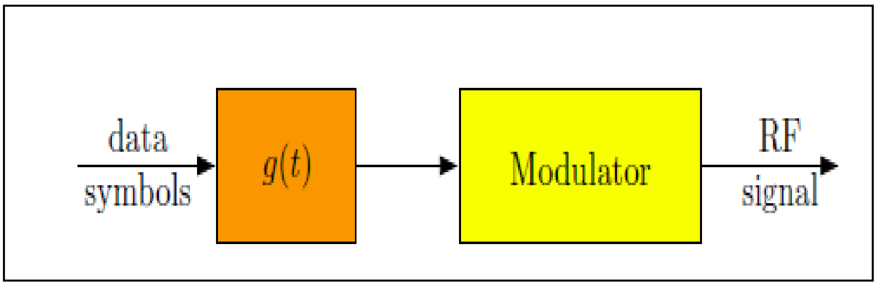

Figure: 2 FBMC Transmitter block diagram

Cosine modulated filter banks and OQAM dependent on FBMC network permits per unit bandwidth a different count of sub carriers. Cosine modulated filter banks and OQAM will have high data rates, when distinct bits are transmitted upon distinct subcarriers.

Received RF signal transmits data regarding timing and acquires carrier tracking. Matched filter is employed for g(t) and generates high amplitude pulses under the level of noise in SS.

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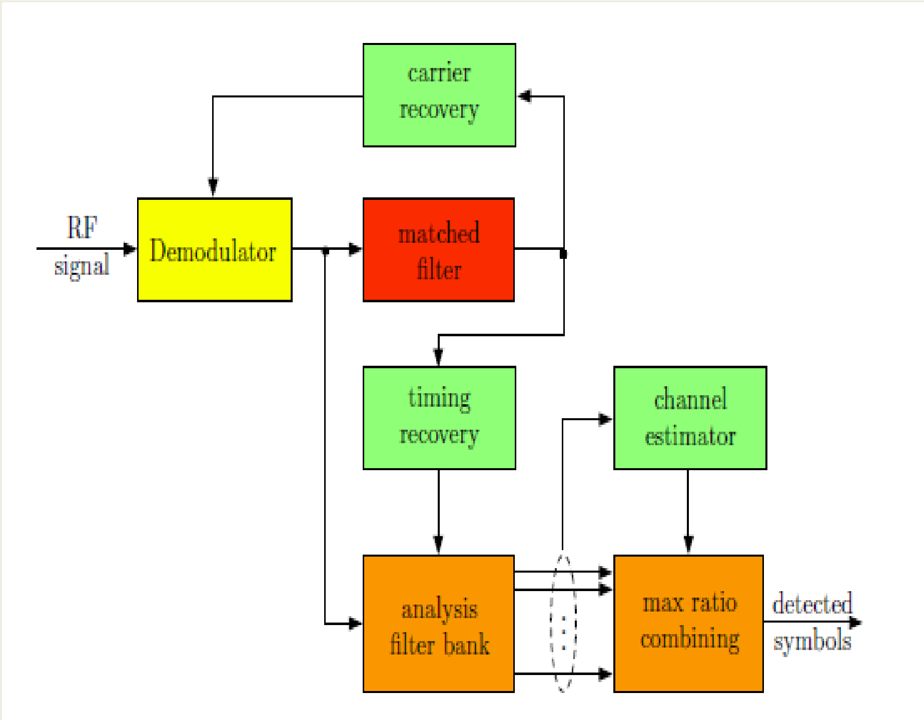

Fig.3. FBMC Receiver block diagram

With the aid of timing recovery the received signal of various sub carriers are samples at right time phase. Channel estimator produces the output as Approximate value of gain of the channel plus noise power interference in every carrier frequency band. Maximum ratio combiner calibrates mean weighted values of data bits for analyzing the filter bank at the output. Noiseless output gives high weights and vice versa. Filter bank multicarrier are classified as three kinds which are discussed here. Also before OFDM, this is the first multicarrier method is filter bank one which is evolved. In 1960s, Chang proposed signalling pulse amplitude modulated symbol sequences via bank of coinciding vestigial side-VSB modulated filters. After a year, Saltzberg improvised

Chang's technique.

Saltzberg observations shows that a FBMC system which is reconstructed perfectly is employed to half-symbol space delay connecting in-phase & QAM symbols with better transmission and reception of symbols in QAM system having high efficieny in the spectrum. Also, Hirosaki in 1980s improvised FBMC. Saltzberg proposed method is called as OFDM-OQAM. Half-symbol space delay connecting in-phase & QAM symbols goes from the offset and is known as staggered modulated multitone. Here, staggered means that the in-phase & QAM symbols are time staggered.

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Subcarriers are managed in a way that no overlapping occurs for successive sub bands in FMT. It is a multicarrier communication technique which adopts frequency division multiplexing in segregating high data rate bits into many number of distinct frequency bands.

4. Simulation Results

Out of all the multicarrier techniques, OFDM is a specific type with more advantages in digital communications. OFDM is employs an inverse and forward DFT. In this, rectangular window filter having the length same as length of transmission blocks. Here the sub channel filters are perpendicular. So, we can recover a perfect signal. We use MATLAB for experimental results.

Generally OFDM employs cyclic prefix. It is larger in comparison with maximum multipath delay that removes ISI present in the channel. Moreover, sub channels are not separated well spectrally. Main lobe coincides with consecutive sub channels. Also, high side lobes moves up to a wide frequency band. Main lobes mix with side lobes in the whole spectrum.that results in extended inter carrier interference in fast fading.

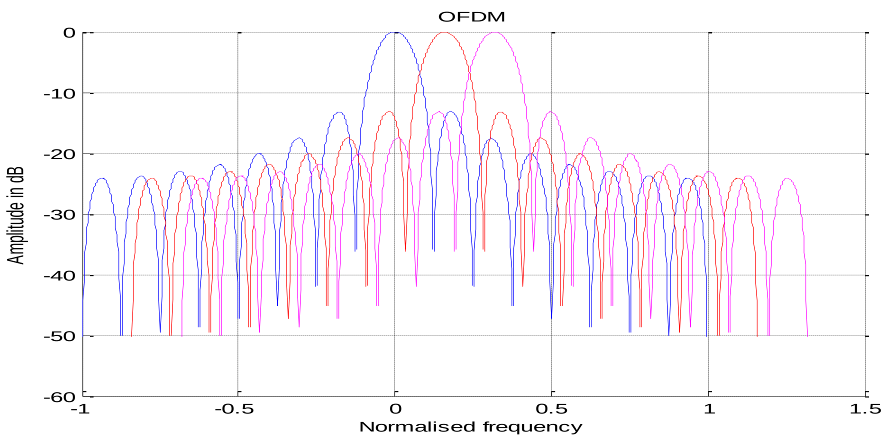

Fig.4. OFDM subcarriers

Table 4.1.Simulation Parameters

Simulation platform	MATLAB R2011b
No of Sub carriers	512
Overlapping Factor	4
No of OQAM Symbols Per Sample	2

Narrowband interference extends to different consecutive sub channels which is not neglected. Generally the above techniques are known as filter bank based multicarrier.

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Advanced frequency selectivity is achieved by employing spectrally well-shaped filters. Due to this side lobes becomes less in OFDM as shown in the figure.

In fact, any sub channel overlaps significantly only with its neighbouring sub bands. Moreover, the consecutive symbol waveforms are highly overlapping in time when the frequency selectivity of subchannels is improved. Due to the overlapping symbols, a cyclic prefix approach is not needed.

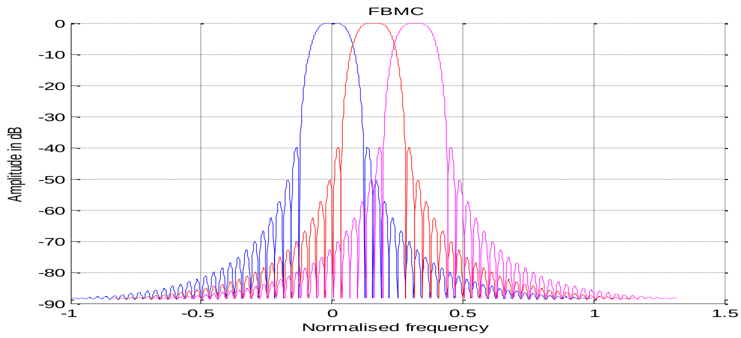

Fig.5 FBMC subcarriers

Frequency response is the quantitative measure of the output spectrum of a system or device in response to a stimulus, and is used to characterize the dynamics of the system. Fig.4.3 shows the magnitude response of the prototype filter in the case of K=3, M=16, L_p = 63.The filter co-efficient derived is shown in the Table 4.2 for different values of K.

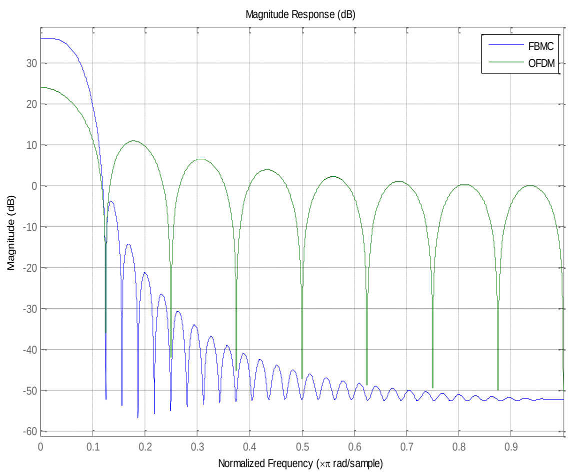

Fig.6 Frequency response of OFDM and FBMC

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In practical FBMC systems, it is tempting to construct synthesis and analysis filter banks using a prototype filter that is as short as possible but still able to provide acceptable performance.

Table 4.2 Filter Coefficients of Prototype Filter

K	H_0	H_1	H_2	H_3
2	1	$1/\sqrt{2}$	-	-
3	1	0.911438	0.411438	-
4	1	0.971960	$1/\sqrt{2}$	0.235147

The number of subchannels is selected to be M = 16, M=512 and conclusions are drawn based on the presented results. The response of the prototype filter is good for values of K=3 and K=4 comparable to K=2. In order to choose correct value of K, two important points must be considered. The narrow band interference should be chosen as a minimum value. When K is increasing, the side lobes of filters are decreased, the result in the narrow band interference will be decreased. But when K is higher than 4 the side lobes will be slowly decreased compared when K=4.

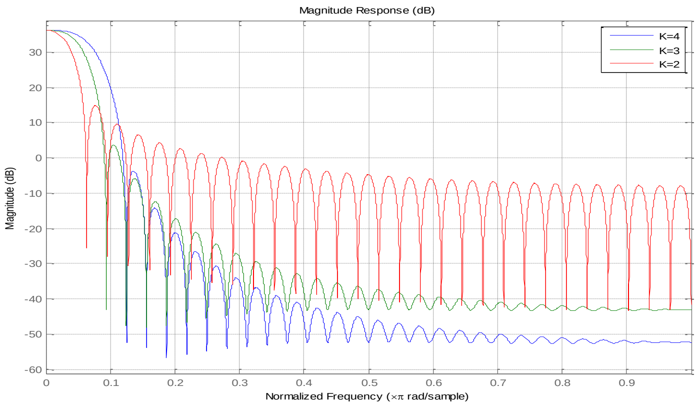

Fig.7 Magnitude response of FBMC in the case of M=16, $L_P = KM - 1$

5. Conclusion

FBMC-SS as an UCC for cognitive radio is focussed and explained. Key advantage of UCC is presented and control channel for the cognitive radio is designed using OQAM/FBMC system using MATLAB for improving the spectrum utilization. After designing the control channel transmitter and receiver, it is also important to evaluate the result regarding data-aided synchronization and channel approximation.

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