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Power Allocation for OFDM Based AF Cooperative Diversity Systems using Water Filling Algorithm in CRN

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Abstract

In Cognitive Radio Networks (CRN), the existing power allocation literature works involves non-uniform power allocation to sub-carriers. Also the major drawback of OFDM is its sensitivity to frequency offset between the transmitted and received carrier frequencies. Hence in this paper, we propose power allocation for OFDM based AF cooperative diversity systems using water filling algorithm in CRN. This technique initially allocates the power to subcarriers uniformly, and then gives an approximate equivalent channel gain model. Since OFDM is sensitive to frequency offset among the transmitted and received carrier frequencies, the Inter-Carrier Interference (ICI) is mitigated using the techniques such as ICI Self-Cancellation and Extended Kalman Filter (EKF). By simulation results, we show that the proposed technique improve the average rate especially when the relay is close to the source and also improve the performance.

Key words: Cognitive Radio Networks (CRN), Carrier Interference (ICI), Extended Kalman Filter (EKF), Amplify and Forward (AF)

1. Introduction

1.1 Cognitive Radio Networks (CRN)

Cognitive radio is a radio that can change its transmitter parameters according to the interactions with the environment in which it operates. It is also known as dynamic spectrum access (DSA) networks and it is the key enabling technology that enables next generation communication networks. Using the cognitive radio networks we can utilize the spectrum more efficiently in an opportunistic fashion without interfering with the primary users.

Cognitive radio comes up with the solution to the spectral congestion problem by introducing opportunistic usage of the frequency band that is not heavily occupied by licensed users. Cognitive radio is equipping users with cognitive capability and reconfigurability. Cognitive capability means the ability to sense and gather information from the surrounding environment. The information is about bandwidth, power, frequency, modulation, etc. using this capability's secondary users easily identify the best available spectrum. Reconfigurability means the ability to rapidly adapt the operational parameters according to the sensed information in order to achieve the optimal performance.

Reconfigurability refers to the ability to rapidly adapt the operational parameters according to the sensed information in order to achieve the optimal performance. By make use of the spectrum in an opportunistic fashion, cognitive radio enables secondary users to sense which portion of the spectrum are available, select the best available channel, coordinate spectrum access with other users, and vacate the channel when a primary user reclaims the spectrum usage right. One main characteristic of cognitive radio is related to autonomously exploiting locally unused spectrum to provide new paths to spectrum access. The most important components of the cognitive radio is be aware of parameters related to the radio channel characteristics, availability of spectrum and power, radio's operating environment. [16][17][19]

1.2 Orthogonal Frequency Division Multiplexing (OFDM)

OFDM (Orthogonal Frequency Division Multiplexing) is a basic block modulation technique, which converts a wideband frequency selective fading channel into a number of parallel narrowband orthogonal sub-carriers that experience only flat fading. The prime advantage of OFDM lies in its ability to cope with severe frequency-selective fading due to multipath without complex equalization filters. The main advantage or one of the main reasons to use OFDM is to increase the robustness against frequency selective fading. OFDM can be seen as either a modulation technique or a multiplexing technique. [1][2][3]

OFDM is a special case of multicarrier transmission and it can be seen as either a modulation technique or a multiplexing technique. An interferer can cause the entire link to fail when it is in a single carrier system, a single fade, but it will be only a small percentage of the subcarriers will be affected in multicarrier system. Error correction coding can then be used to correct for the few erroneous subcarriers. [1][2][3]

The advantages of using the OFDM are, we can eliminate the ISI and IFI through use of a cyclic prefix, and we can make efficient use of the spectrum by go beyond the spectrum. We recover the symbols lost using the adequate channel coding and interleaving. By dividing the channel into narrowband flat fading sub channels, OFDM is more resistant to frequency selective fading than single carrier systems are. By using adaptive equalization techniques with single carrier systems the Channel equalization becomes simpler. We can provide good protection against co-channel interference and impulsive parasitic noise. [1][2][3]

Some of disadvantages of OFDM are, the OFDM is more sensitive to carrier frequency and drift than single carrier systems are due to leakage of the Discrete Fourier Transform (DFT). The OFDM requires RF power amplifiers with a high peak to average power ratio due to the signal has a noise like amplitude with a very large dynamic range. We can create the OFDM modulation technique through the use of complex signal processing approach. The fast Fourier transforms (FFTs) and inverse FFTs in the transmitter and receiver sections of the radio are the complex signal processing approaches. OFDM is also spectrally efficient because the channels are overlapped and contiguous. [2][3][4]

1.3 Power Allocation for OFDM

OFDM is a promising technique to moderate the affection of frequency selectivity. Due to the frequency selectivity, each subcarrier experiences different fading. When each subcarrier understanding different fading it requires more power and it is required to allocate the total power to each subcarrier to provide a higher system capacity. For the dual-hop transmission, the first hop (source to relay link) and the second hop (relay to destination link) is mutually independent.

Waterfilling algorithm is an optimal power allocation approach in single-hop OFDM systems. But in conventional waterfilling algorithm the power allocation was not always efficient. This is not efficient due to the interference caused by the sidelobes in different subcarriers. The transmit power of each subcarrier should be adjusted according to the channel status and the location of the subcarrier with respect to the PU spectrum. Power allocation in OFDM is very important. Waterfilling is proved to be the optimal power allocation method for OFDM system with only noise experienced. [5][6][7]

1.4 Amplify-and-forward (AF) Cooperative Diversity Systems

We may not provide the significant performance improvement due to the closer antennae. The closer antenna lead to increased correlated fading characteristics. Cooperative diversity is overcome this limitation. Cooperative diversity becomes the most emerging research area for the researches in recent years. Cooperative diversity (CD) is making use the multiple antennae to improve received signal quality. CD is different to MIMO systems; it relies on data transmission by several nodes. Each node acts as a virtual antenna and CD data to a particular destination. Since each node tends to be at different places, cooperative diversity benefits from the tendency to find multiple antennae with independent fading.

CD is classified as two main categories. One is amplify-and-forward cooperative diversity (CD-AF) and second one is decode-and-forward cooperative diversity (CD-DF). In CD-AF, each cooperative node simply amplifies and forwards the received signal towards the destination node. In CD-DF, each cooperative node in this type decodes and re-encodes the received signal before forwarding the signal to the destination.

CD-AF is useful in maintain the simplicity and cost effectiveness. CD-DF is useful in avoiding of error propagation. The CD-AF is transparent under adaptive modulation, and is able to maintain the maximum diversity order as the number of cooperative nodes increases. This paper focuses on the CD-AF type. The main advantage of cooperative diversity is broadcast nature of the wireless medium, along with the ability to achieve diversity through independent channels. . The cooperating terminals create spatial diversity for each other hence they are able to form virtual antenna arrays which exploit all the benefits that multiple transmission/reception entails. [8][9][10]

In distributed wireless network we will get more Cooperative diversity gain with nodes that help each other to relay transmissions. Amplify-and-Forward (AF) relaying is one of the most popular cooperation protocols. The relay simply amplifies the signal received from the source and transmits the amplified signal to the destination. It requires no decoding at relay nodes and hence is well-suited to systems with simple relay units such as wireless sensor networks. The merging of relay provides a convenient solution for extending coverage and improving capacity and relaying technique has attracted much attention among wireless communication. The amplify-and-forward (AF) and decode-and-forward (DF) are two main relaying strategies. The AF relay retransmits the received signal only with power amplification, while the DF relay decodes the signal and re-encodes it before retransmission. . DF relaying has the main advantage that the transmission can be optimized for both links separately and a lot of research has been done to analyze its performance. The optimization problem is more complex in multi-relay transmission because each relay may only occupy part of the total bandwidth. [8][9][10]

1.5 Problem Identification

The approach which is proposed in [13] is a new water-filling algorithm for power allocation in Orthogonal Frequency Division Multiplexing (OFDM) – based cognitive radio systems. The conventional water-filling algorithm cannot be directly employed for power allocation in a cognitive radio system, because there are more power constraints in the cognitive radio power allocation problem than in the classic OFDM system.

The following drawbacks are observed in this approach:

1. In this scheme power was not allocated uniformly to the subcarriers.
2. They are not considering the well-known problem of OFDM is its sensitivity to frequency offset between the transmitted and received carrier frequencies.

In this paper, we propose Power Allocation for OFDM Based AF Cooperative Diversity Systems using Water Filling Algorithm in CRN.

2. Literature Review

Shen Zhenhui et al., [11] have proposed an associated waterfilling power allocation scheme under separate power constraints at source and relay, which allocated source and relay power in an associated fashion. The scheme first allocated power to subcarriers uniformly, then gave an approximate equivalent channel gain model, and last employed the classic waterfilling algorithm to optimize the power allocation at relay and source, respectively. Moreover, they investigated the subcarrier pairing problem and presented a modified sorted subcarrier pairing algorithm, which considered the effect of source-destination link as well as source-relay link. The main advantage of this scheme is it can improve the average rate especially when the relay is close to the source.

Qilin Qi et al., [13] have proposed a new water-filling algorithm for power allocation in Orthogonal Frequency Division Multiplexing (OFDM) – based cognitive radio systems. The conventional water-filling algorithm cannot be directly employed for power allocation in a cognitive radio system, because there are more power constraints in the cognitive radio power allocation problem than in the classic OFDM system. In this paper, a novel algorithm based on iterative water-filling is presented to overcome such limitations. However, the computational complexity in iterative water-filling is very high.

Hui Wang et al., [14] have proposed a new power allocation problem for OFDM systems with two cooperative transmitters, where each transmitter has an individual power constraint and can obtain their own perfect channel state information (CSI). The transmitters first cooperate by sharing the CSI, and then jointly optimize power allocation in the metric of sum throughput, which can be modeled as a non-convex constrained optimization problem. Through an application of Karush-Kuhn-Tucker conditions, the problem is reformulated as a convex one. Then, the closed form solution is derived with the nature of traditional WF as well as cooperative properties. Based on the derived solution, an iteration algorithm for joint water level is given for the first time, which can be explained as a cooperative WF relative to the traditional WF.

Somnath Das et al., [15] have proposed a suboptimal power loading algorithm that maximizes the downlink transmission data rate of the BS2 while the interference introduced to the BS1 user remains within a given limit. Here they have derived a general closed-form equation of system capacity taking multiple cells into consideration and then they have investigated a coordination technique for interference mitigation. The proposed algorithm is simpler and more efficient in terms of throughput performance.

Ebtihal Haider Gismalla et al., [19] have proposed accurate Performance analysis of Energy Detection using Bartlett's Estimate for Spectrum Sensing in Cognitive Radio Systems. The novel contribution here is threefold. First, the quadratic form representation of Bartlett's estimate is formulated. Then, starting from the characteristic function, the cumulative distribution function is derived for each type of channel and accurate expressions are developed for the probabilities of false alarm and missed detection. Finally, a performance comparison with the raw periodogram is presented. The accuracy of the proposed analysis is confirmed using Monte Carlo trials.

Tian Zhang et al., [20] have proposed Stackelberg game and the game is built to model the hierarchic power allocation of primary user (PU) network and secondary user (SU) network in OFDM-based cognitive radio (CR) networks. A Stackelberg game is formulated to describe the priority of the power allocation for the PU network. They analyze the mutual effect between power allocation for the PU network and that of the SU network in two aspects: ISR constraint and mutual interference between the PUs and SUs. The former impacts the feasible power allocation set, and the latter influences the utility.

3. Proposed Solution

3.1 Overview

In this paper, we propose power allocation for OFDM based AF cooperative diversity systems using water filling algorithm in CRN. This technique initially allocates the power to subcarriers uniformly, and then gives an approximate equivalent channel gain model. Since OFDM is sensitive to frequency offset among the transmitted and received carrier frequencies, the Inter-Carrier Interference is mitigated using the techniques such as ICI Self-Cancellation and Extended Kalman Filter (EKF).

3.2 Water Filling Power Allocation Scheme

3.2.1 Proposed Architecture

Let S, D and R be the source, destination and relay respectively

Let N_i and N_j be the node respectively.

Let C_{ij}^{y} be the complex gain of y^{th} subcarrier of the channel among N_i and N_j

Let P_{i}^{y} be the power allocated to y^{th} subcarrier at N_i

Let (y, y’) be the sub-carrier pair. (i.e.) the y^{th} subcarrier of S is paired with y'^{th} subcarrier of R

Our proposed architecture includes a S, D and R. (Shown in Figure 1). The data transmission occurs from S to D with the help of R. i.e.

Initially S transmits data to R and D.

R then forwards the received information using amplify and forward (AF) relaying methodology.

The channel among each N_i is considered to be frequency selective fading channels. An Orthogonal frequency-division multiplexing (OFDM) is utilized. In this technique, the total bandwidth is divided into Y subcarriers and channel on each sub-carrier is flat.

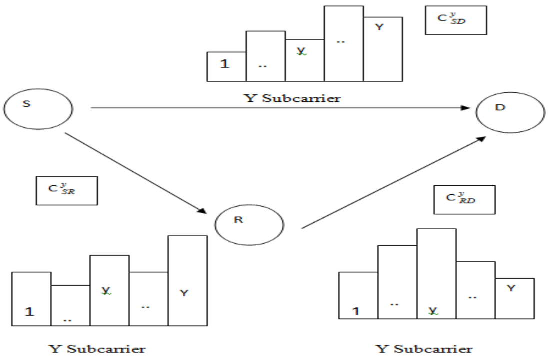

Figure 1. Proposed Architecture

The SNR received on (y, y’) at D is given using the following Eq. (1)

$$\mathrm{SNR}_y = \mathrm{P}_S^y b^y + \frac{P_S^y q^y P_R^{y'} w^{y'}}{P_S^y q^y + P_R^{y'} \left| w^{y'} \right| + 1} \tag{1}$$

Where $b^y = \left| C_{SD}^y \right|^2 / \alpha^2$

$q^y = \left| C_{SR}^y \right|^2 / \alpha^2$

$w^y = \left| C_{RD}^{y'} \right|^2 / \alpha^2$

α = power of Gaussian noise on one subcarrier

The instantaneous rate at which the signal transmission is performed from S to D is shown using following Eq. (2)

$$\mathrm{IR} = \frac{1}{2Y} \sum_{y=1}^{Y} \log(1 + SNR_y) \tag{2}$$

where factor ½ reveals that the signal is transmitted repeatedly over two slots.

3.2.2 Source and Relay Power Allocation technique

Let power at S and R be separately constrained.

The mathematical model of optimal power allocation is shown using Eq (3)

$$\{\mathrm{P}_S^{'}, \mathrm{P}_R^{'}\} = \arg \overset{\max}{P_S, P_R} \frac{1}{2Y} \sum_{y=1}^{Y} \log\left(1 + \mathrm{P}_S^y b^y + \frac{P_S^y q^y P_R^{y'} w^{y'}}{P_S^y q^y + P_R^{y'} \left| w^{y'} \right| + 1}\right) \tag{3}$$

Subject to $\sum_{y=1}^{Y} P_S^y = P_S,\ P_S^y \geq 0$

$\sum_{y=1}^{Y} P_R^y = P_R,\ P_R^y \geq 0$

Where P_i = power allocation vector ($\mathrm{P}_i = \mathrm{P}_i^1, \ldots, \mathrm{P}_i^y, \ldots \mathrm{P}_i^Y$ = power constraint at N_i)

The power optimization model at R is given using Eq (4)

$$\mathrm{P}_R^{'} = \arg \overset{\max}{P_R} \frac{1}{2Y} \sum_{y=1}^{Y} \log\left(1 + \mathrm{P}_S^{y_0} b^y + \left| \tilde{C}_R^{y'} \right|^2 P_R^{y'}\right) \tag{4}$$

where $\mathrm{IR} = \frac{1}{2Y} \sum_{y=1}^{Y} \log\left(1 + \mathrm{P}_S^{y_0} b^y + \left| \tilde{C}_R^{y'} \right|^2 P_R^{y'}\right)$

$P_R^{y'} = (C^R - (1+P_S^{y_0} b^y) / \left|\tilde{C}_R^{y'}\right|^2)$ [derived using Karush-Kuhn-Tucker (KKT) conditions]

The power optimization model at S is given using Eq. (5)

$$P'_S = \arg \overset{\max}{P_S} \frac{1}{2Y}\sum_{y=1}^{Y}\log(1+\left|\tilde{C}_S^{y'}\right|^2 P_S^y) \qquad (5)$$

Where IR = $\frac{1}{2Y}\sum_{y=1}^{Y}\log(1+\left|\tilde{C}_S^{y'}\right|^2 P_S^y)$

$P_S^y = (C^S - 1/\left|\tilde{C}_S^{y'}\right|^2)$

3. 2. 3 Inter-Carrier Interference (ICI)

OFDM is sensitive to frequency offset among the transmitted and received carrier frequencies. In order to mitigate the effect of Inter-Carrier Interference (ICI), in this paper we introduce two techniques.

1. ICI Self-Cancellation (SC)
2. Extended Kalman Filter (EKF)

1) ICI Self-Cancellation (SC)

The ICI self-cancellation is defined as the modulation of input data onto a sub-carrier group with pre-defined co-efficient such that the generated ICI signals within the group cancel each other.

For example. Consider the following condition.

Let δ be the data symbol in first carrier y_1 and - δ be data symbol in second carrier y_2

```
If ($\delta$ is modulated in $y_1$) and (- $\delta$ is modulated in $y_2$)
Then
    ICI generated among $y_1$ & $y_2$ mutually cancel each other.
End if
```

This technique is mainly suitable for multipath fading channels and flat channels.

The above described ICI cancelling modulation and demodulation is explained below.

ICI Cancelling Modulation

Let τ be the channel frequency normalized by subcarrier separation

The received signal on subcarrier y is

$$\underbrace{RS\,(n) = TX\,(u)}_{\text{Desired Signal}}\,\xi(0) + \underbrace{\sum_{v=0,u\neq v}^{n-1} TX(v)\xi(u-v)+\theta_v}_{\text{ICI Component}}, \quad v = 0,1,\ldots,n-1 \qquad (6)$$

where n = total number of sub-carriers

TX(u) = transmitted symbol for u subcarrier

θ_v = additive noise sample

$\xi(u-v)$ = ICI coefficient among u^th^ and v^th^ subcarrier

$$\xi(u-v) = \frac{\sin(\pi(u+\tau-v))}{n\sin(\frac{\pi}{n}(u+\tau-v))}.\exp(j\pi(1-\frac{1}{n})(u+\tau-v)) \quad (7)$$

From the above equation, it is clear that [$\xi(u-v)$ - $\xi(u+1-v)$] is small. Hence,

If (δ ,- δ) is modulated onto two adjacent subcarriers (u, u+1)

Then

ICI signals generated by u is cancelled by u+1

End if

ICI Cancelling Demodulation:

In order to reduce ICI further, ICI cancelling demodulation is performed. In this technique, the each signal at $(v+1)^{th}$ subcarrier is multiplied by “-1” and then added with one of v^{th} subcarrier. The resultant received signal is shown using following equation

RS” (v) = RS’ (v) – RS’(v+1)

$$= \sum_{\substack{u=0 \\ u=even}}^{n-2} TX(u)[-\xi(u-v-1)+2\xi(u-v)-\xi(u-v+1)]+\theta_v-\theta_{v+1} \quad (8)$$

The corresponding ICI coefficient then becomes,

$$\text{RS''(u-v)} = -\xi(u-v-1)+2\xi(u-v)-\xi(u-v+1) \quad (9)$$

Thus the ICI signals become further smaller after applying ICI cancelling demodulation.

2) Extended Kalman Filter

Kalman filter is recursive estimation algorithm. It finds its application in communications, such as adaptive equalization of telephone channels, adaptive equalization of fading dispersive channels, and adaptive antenna arrays. There exist two levels in Extended Kalman Filter in order to mitigate ICI effect.

1. Offset Estimation
2. Offset Correction
3. Offset Estimation

The steps involved in Offset estimation is as follows

Estimate τ ’(0) and respective state error SE(0) .The value τ ’(0) is estimated using the following equation

τ (n) = τ (n-1)

Compute B (n) which is derivative of a(n) with respect to τ (n) at τ (n-1)

$$\text{B(n) = d (a (n)) = d (p(n)e}^{j\frac{2\pi n'\tau(n)}{n}} + \theta(n) \quad (10)$$

where a(n) = received preamble symbols distorted in the channel

$\theta(n)$ = additive white Gaussian noise

p(n) = inverse fast Fourier transform of the preambles P(n) which is t transmitted.

1. Estimate the time-varying Kalman gain $\beta(n)$ using the error variance parameters SE(n-1), B(n) and variance μ^2.
2. Estimate a'(n) using p(n) and τ'(n-1). Based on the observations upto n-1, error is estimated among a(n) and a'(n).
3. By adding $\beta(n)$, update τ'(n)
4. Estimate the state error SE(n) using $\beta(n)$, B (n) and SE(n-1)
5. If n < N_{ap},

Then
    Increment n by 1
    Return to step 2
Else
    Terminate.

Where N_{ap} is the number of preambles preceding the data symbols in each frame

Offset Correction

The ICI distortion in data symbols p (n) can be reduced by multiplying B(n) with complex conjugate of estimated frequency offset and applying fast fourier transform. This is expressed using the following equation.

$$P'(n) = FFT\left\{ B(n)e^{-j\frac{2\pi n'\tau'}{n}} \right\} \quad (11)$$

This technique causes the performance to be greatly influenced by the variation of additive white guassian noise.

4. Simulation Results

The parameters used for the Orthogonal Frequency Division Multiplexing is given below in the table 1 for standard OFDM and ICI self cancellation method and table 2 for Extended Kalman Filter method.

Tabel1: Standard OFDM and ICI self cancellation methods:

Parameters	Specification
FFT Size	64
Number of Carriers in OFDM symbol	52
Channel	AWGN
Doppler Shift	0.02,0.05,0.002
Signal Constellation	PSK
OFDM symbols for one loop	100
SNR	1:2:35

Table2: Extended Kalman Filter method

Parameters	Specification
FFT size	64
Preamble size	256
Sub carriers size	512
Signal Constellation	PSK
Number of OFDM frames	256

In order to compare the two different cancellation schemes, BER curves were used to evaluate the performance of each scheme. For the simulations in this project, MATLAB was employed with its Communications Toolbox for all data runs. Modulation schemes of binary phase shift keying (BPSK) is chosen as it is used in many standards such as 802.11a. Simulations for cases of normalized frequency offsets equal to 0.05, 0.02, and 0.002 are used [3].

The main idea is to modulate the input data symbol onto a group of sub carriers with predefined coefficients such that the generated ICI signals within that group cancel each other, hence the name self-cancellation.

To analyze the effect of ICI on the received signal, we consider a system with N=16 carriers. The frequency offset values used are 0.2 and 0.4, and L is taken as 0, that is, we are analyzing the signal received at the sub-carrier with index 0. The complex ICI coefficients S (l-k) are plotted for all sub carrier indices k in Figure (1).

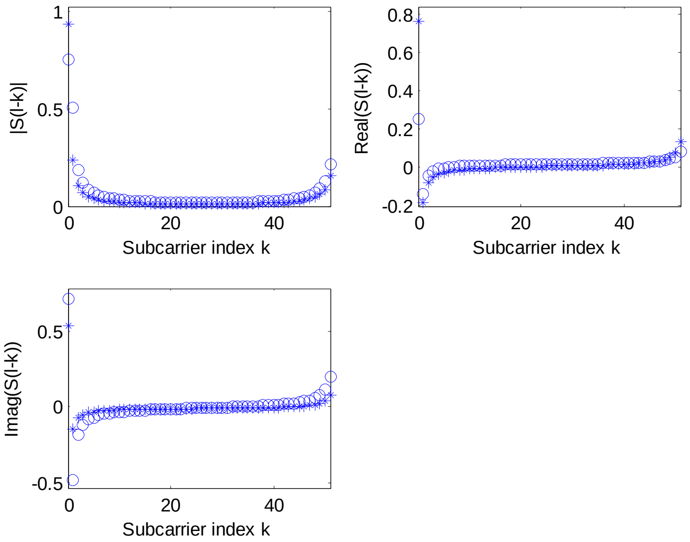

Figure 1. ICI Coefficients for N=16 Carriers

In ICI self cancellation method, the figure 2 shows a comparison between |S’ (l-k)| and |S (l-k)| on a logarithmic scale. It is seen that |S’ (l-k)| << |S (l-k)| for most of the l-k values. Hence, the ICI components are much smaller than they are. Also, the total number of interference signals is halved as opposed to since only the even sub carriers are involved in the summation

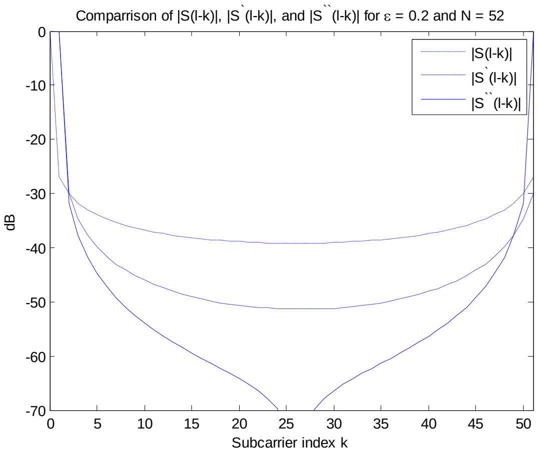

Figure.2 Comparison between |S (l-k)|, |S’ (l-k)| and |S” (l-k)|

ICI modulation introduces redundancy in the received signal since each pair of sub carriers transmit only one data symbol. This redundancy can be exploited to improve the system power performance, while it surely decreases the bandwidth efficiency. Figure 3 shows the comparison of the theoretical CIR curve of the ICI self-cancellation scheme, calculated, and the CIR of a standard OFDM system calculated. As expected, the CIR is greatly improved using the ICI self-cancellation scheme.

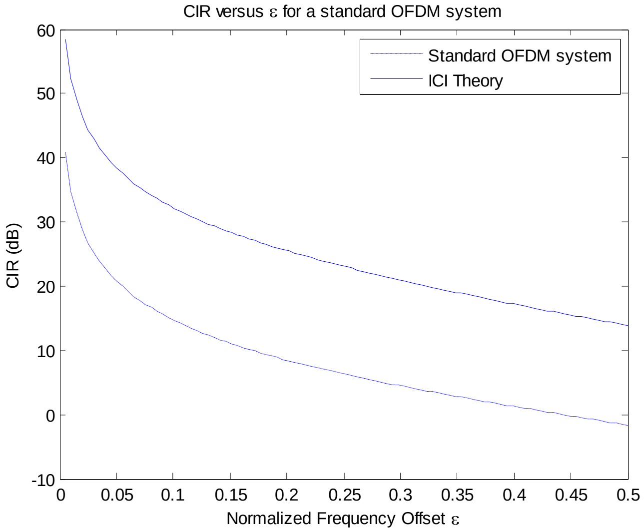

Figure.3 CIR improvement using ICI self-cancellation scheme

From below figure 4, 5 and 6 BER of AF-OFDM for different frequency offsets is shown. In which we can see that the AF-OFDM for the extended Kalman filter shows the better performance (the bit error rate reduces as the signal to noise ratio increases) when compared to the normal amplify and forward based orthogonal frequency division multiplexing and inter carrier interference based on the self cancellation method. The bit error rate reduces at 15 db when the Doppler shift is 0.002 as shown in figure 4 for the extended Kalman filter [4]. When the Doppler shift is 0.02 the bit error rate reduces at 18 db as shown in figure 5 and for the Doppler shift 0.05 the bit error rate reduces at 15 db whereas for the normal process and self cancellation method in cognitive radio network its bit error rate reduces at 35 db [3].

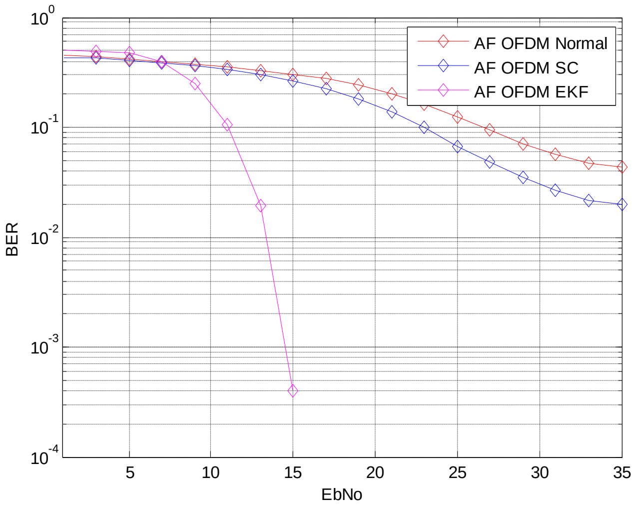

Figure.4 BER vs. SNR for the value of ep=0.002

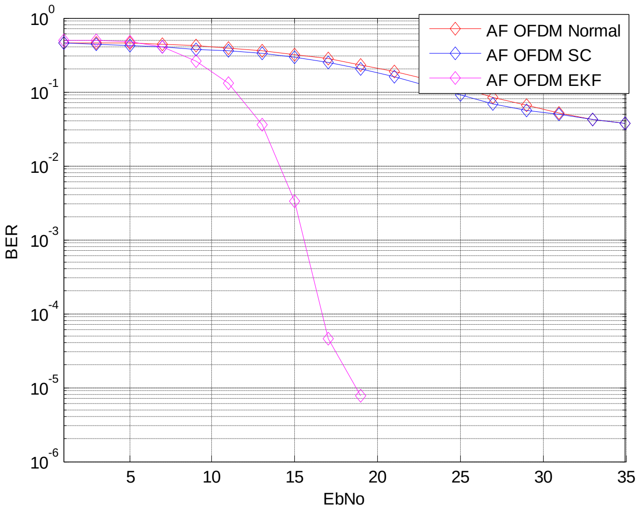

Figure.5 BER vs. SNR for the value of ep=0.02

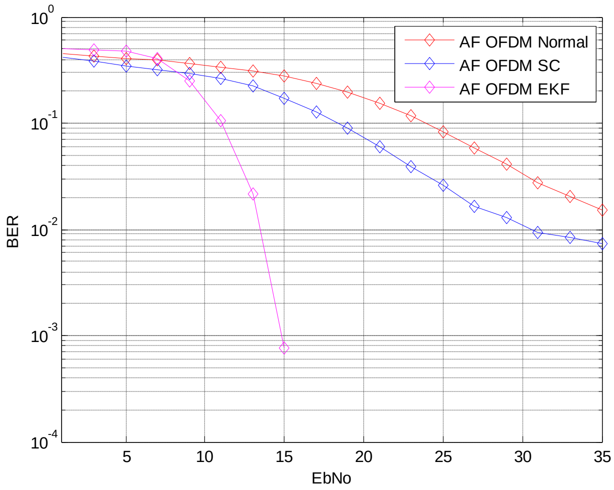

Figure.6 BER vs. SNR for the value of ep=0.05

The figure 7 shows the capacity vs. number of users for the amplify and forward orthogonal frequency division multiplexing in cognitive radio network that for each user the capacity increases for our waterfilling based power allocation method when compared to the optimal power allocation.

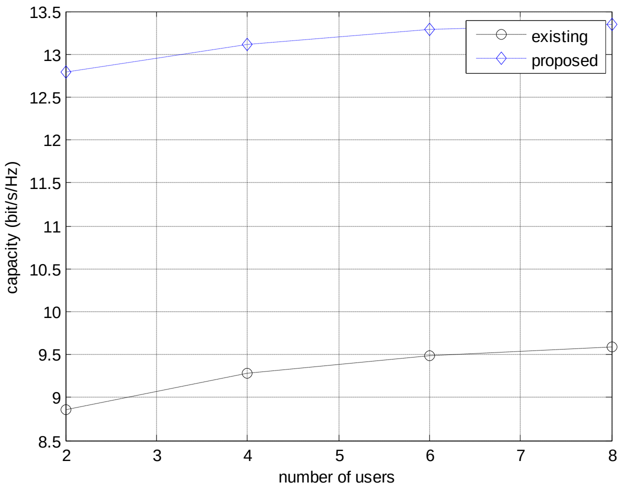

Figure.7 Capacity vs. Number of users for Existing and proposed work

The figure 8 shows the graph for the existing and proposed work of BER vs. SNR in which the waterfilling based power allocation shows better performance the bit error rate decreases at 26 db when compared to that of optimal power allocation.

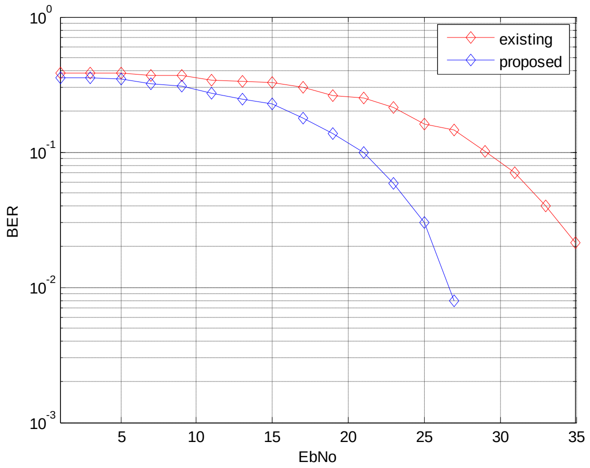

Figure.8 BER vs. SNR for optimal power allocation and waterfilling based power allocation

5. Conclusion

In this paper, we have proposed power allocation for OFDM based AF cooperative diversity systems using water filling algorithm in CRN. This technique initially allocates the power to subcarriers uniformly, and then gives an approximate equivalent channel gain model. Since OFDM is sensitive to frequency offset among the transmitted and received carrier frequencies, the Inter-Carrier Interference is mitigated using the techniques such as ICI Self-Cancellation and Extended Kalman Filter (EKF). By simulation results, we have shown that the proposed technique improve the average rate especially when the relay is close to the source and also improve the performance.

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