Review Paper on MIMO-OFDM System based on Cognitive Radio Networks

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Abstract-The fundamental tasks that are used in the cognitive radio (CR) networks are spectrum shaping capability and multi carrier systems. In these structures activation of fundamental (primary) users will generate a defined number of sub carriers in the second users. Therefore overall capacity of cognitive radio network is minimized. The small capacities antennas are neutralized by using OFDM based cognitive radio system although various transmit antennas are applied. These considerations examine the complication of resource allocation in MIMO based cognitive radio networks. This paper discusses the model building of MIMO-OFDM using MATLAB R2012b version. This model is a using tool for MSE (Mean Square Error) and Signal to Noise Ratio (SNR) performance evaluation for signal & multiple input output port by the WiMAX (IEEE 802.16) system.

Keywords- WiMAX, MIMO-OFDM, Cognitive Radio, MATLAB

I. INTRODUCTION

Wireless communications is a rapidly growing part of the communications field, with the believable to provide high-speed and high-quality information swap between portable devices located anywhere in the world. It has been the topic of study since last two decades the terrific development of wireless communication technology is due to several factors. The demand of wireless connectivity is exponentially increased. Second, the dramatic progress of VISL technology has enabled small-area and low-power implementation of sophisticated signal processing algorithm and coding algorism. Third, wireless communication standards, like CDMA, GSM, TDMA, make it possible to transmit voice and low volume digital data. Further, third generation of wireless communications can offer users more advanced service that achieves greater capacity through improved spectral efficiency.

Potential applications enabled by this technology include multimedia cell phones, smart homes and appliances,automated systems, video teleconferencing and distance learning, and autonomous sensor networks.

However, there are two significant technical challenges in supporting these applications first is the phenomenon of fading the time variation of the channel due to small-scale effect of multi-path fading, as well as large-scale effect like pass loss by distance attenuation and shadowing by obstacles. Second, since wireless transmitter and receiver need communicate over air, there is significant interference between them [2].

The intelligent wireless system is called as Cognitive radio (CR) that identifies the spectrum movement in surroundings at each instant. Thus it adapt its parameters such as modulation type, carrier's frequency etc. It has two fundamental purposes they are highly reliable communication whenever and where ever needed and efficient utilization of radio spectrum. Cognitive spectrum sharing was recently studied to allow increasing demands for wireless broadband access which can reduce the problem of under-utilization of licensed spectrum. These techniques can be generally classified into three types: one is interweave, second is underlay and third is overlay [3].

The secondary system can opportunistically access spectrum holes for interweave spectrum sharing. And for the spectrum underlay second users (SUs) transmit simultaneously with fundamental (primary) users (PUs) under the constraint that interference caused by the SUs on the PUs must be below a certain threshold. In spectrum overlay SUs actively help primary data transmission in exchange for a spectrum access in time domain, spatial domain or frequency domain [4]. The locations of SUs are usually fixed or limited into a small area without suffering interference from other concurrent transmissions. For more than a decade, Adaptive resource allocations (RA) for the OFDM systems have been studied [5]. As the OFDM-based CR systems are arising, the adaptive Resource Allocation (RA) attracted much attention starting from the broaching. Thus in the case of single SU, Resource Allocation in an OFDM-based CR system degenerates in to power distribution. The capacity of CR networks can be expanded by using the approach OFDM based CR networks for which different transmit antennas are applied to that approach. Recently, the great attention has been attracted by the combination of MIMO and OFDM [6-7]. The capacity and divergence gain can be increased by using the MIMO in the hybrid pattern channel while the frequency selective channel is converted in to flat fading channels by using the OFDM.

II. LITERATURE REVIEW

Cognitive radio (CR) in conjunction with multiple-input multiple-output orthogonal frequency-division multiple access (MIMO-OFDMA) is a candidate technology for future mobile radio networks. The short communication range of underlay CR systems is commonly a major limiting factor. In this paper, had propose a computationally and spectrally efficient resource allocation scheme for multiuser MIMO-OFDM based underlay CR networks to provide good spectral efficiency gain, and therefore increased communication range. The scheme is optimal for the downlink but, however, near-optimal for the uplink. Simulation results demonstrate the bandwidth and computational efficiencies of the proposed scheme compared to the state-of-the-art by Abdullah Yaqot et al. [1].

In this paper had evaluate the performance of MIMO-OFDM Cognitive radio system where CR devices continuously sense the channel to check whether it is idle or not using compressed sensing with cyclostationary detection and reconstruct the signal if communication is for the given CR receiver from its transmitter. We use the probability of misdetection and probability of false alarm as metrics to evaluate the spectrum sensing, and mean square error (MSE) and successful reconstruction rate (SRR) as metics to evaluate the reconstruction of the signal for CR communication. Simulation results show that the MSE, SNR by dande B. Rawat et al. [2].

Multiple-input multiple-output orthogonal frequencydivision multiplexing (MIMO-OFDM) is considered to be one of the most promising technologies for further generation mobile communication systems like 3GPP LTE in recent years. At the same time, as a smart spectrum sharing technology, Cognitive Radio (CR) was also proposed to enhance the utilization of the spectrum usage. Thus, the combination of MIMO-OFDM and Cognitive Radio, MIMO-OFDM based Cognitive Radio technology is treated as a prospect scheme for future dynamic spectrum access network or spectrum sharing system. Since only a finite number of subcarriers are occupied by the primary users (PUs) in CR networks, the secondary users (SUs) can detect the spectrum holes (the unoccupied subcarriers) and opportunistically access those unoccupied spectrum subcarriers. Thus, spectrum sensing or detection is an important component for the implementation of CR.Besides, our proposed scheme candetect the spectrum usage without the prior information of sparsity, which is also suitable for the real wireless application environment. Simulation results also show the effectiveness of our proposed scheme by Shan Jin et al. [3].

Compressed sensing (CS) is often utilized to lower the complexity of cyclostationary detector (CD) in wideband sensing. In this paper, a methodology is proposed to further simplify the complexity for the combination of CS and CD. Firstly, the relationship between spectral coherence function (SCF) and the compressed samples is deduced in matrix form, thus the reconstruction of original signal can be skipped. Secondly, we notice complexity is highly dependent on compression ratio, which is determined by signal sparsity. Through careful analysis, a strong dependence of sparsity on modulation mode and symbol rate is discovered. Therefore we propose to adjust compression ratio according to the modulation mode and symbol rate of the target signal. To facilitate the adjustment, a modulation classification algorithm based on correlation of SCF is formulated. Moreover, the relationship between compression ratio and performance loss is also explored. Simulation proves our method can reduce complexity significantly with marginal loss in accuracy by Xuan Fu et al. [4].

Detecting the presence of licensed users and avoiding interference to them is vital to the proper operation of a Cognitive Radio (CR) network. Operating in a wideband channel requires high Nyquist sampling rates, which is limited by the state-ofthe-art A/D converters. Compressive sampling is a promising solution to reduce sampling rates required in modern wideband communication systems. Among various signal detectors, feature detectors which exploit a signal cyclostationarity are robust against noise uncertainties. In this paper, we exploit the sparsity of the two-dimensional spectral correlation function (SCF), and propose a reduced complexity reconstruction method of the Nyquist SCF from the sub-Nyquist samples. The reconstruction optimization is formulated as a regularized least squares problem, and its closed form solution is derived. We show that for a given spectrum sparsity, there exists a lower bound on sampling rates that allows reliable SCF reconstruction by Eric Rebeiz et al. [5].

Table 1: Summary of Literature Review

Title	Author/ Publication	Methodolog y	Parameter/ Demerits
Efficient Resource Allocation in Cognitive Networks	Abdullah Yaqot and Peter Adam Hoeher/ IEEE 2017	Design MIMO-OFDM system with the help of cognitive radio network	SNR =21 dB, / No calculate MSE
Evaluation Performance of Cognitive Radio Users in MIMO-OFDM based Wireless Networks	Danda B. Rawat/ IEEE 2016	Design MIMO-OFDM system with cyclo-stationary technique	SNR =15, dB, / More complexit y
Compressive Spectrum Sensing for MIMO-OFDM Based Cognitive Radio Networks	Shan Jin and Xi Zhang/ IEEE 2015	Design MIMO-OFDM system with spectrum sensing technique	MSE = 0.3 for subcarrier = 10/ Not suitable for large Tx

Simplified Cyclostationary Detector using Compressed Sensing	Xuan Fu, Ying Zhut, Jian Yang, Yifan Zhang and Zhiyong Feng/ IEEE 2015	Design MIMO-OFDM system with compressed sensing technique	Detection probability = 0.5/ Not calculate MSE and SNR
Cyclostationary -Based Low Complexity Wideband Spectrum Sensing using Compressive Sampling	Eric Rebeiz, Varun Jain, DanijelaCabric / IEEE 2012	Design MIMO-OFDM system with spectrum sensing with sampling technique	MSE = 0.35 for subcarrier = 10/ Large complixity

III. OVERVIEW OF OFDM AND MIMO SYSTEM

o *OFDM*

Orthogonal frequency-division multiplexing (OFDM) is a method of digital modulation in which the data stream is split into N parallel streams of reduced data rate with each of them transmitted on separate subcarriers. In short, it is a kind of multicarrier digital communication method. OFDM has been around for about 40 years and it was first conceived in the 1960s and 1970s during research into minimizing interference among channels near each other in frequency [2] .OFDM has shown up in such disparate places as asymmetric DSL (ADSL) broadband and digital audio and video broadcasts. OFDM is also successfully applied to a wide variety of wireless communication due to its high data rate transmission capability with high bandwidth efficiency and its robustness to multi-path delay [7-8].

The basic principle of OFDM is to split a high data rate streams into a number of lower data rate streams and then transmitted these streams in parallel using several orthogonal sub-carriers (parallel transmission). Due to this parallel transmission, the symbol duration increases thus decreases the relative amount of dispersion in time caused by multipath delay spread. OFDM can be seen as either a modulation technique or a multiplexing technique.

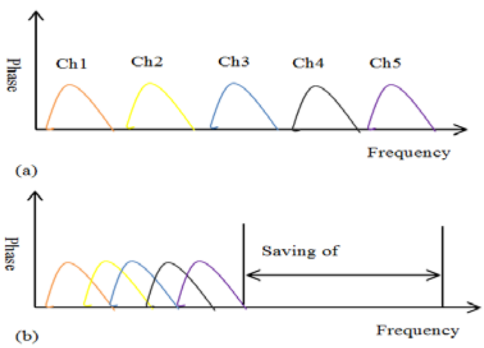

Figure 1: Comparison between conventional FDM (a) and OFDM (b)

MIMO

MIMO has been developed for many years for wireless systems. One of the earliest MIMO to wireless communications applications came in mid-1980 with the breakthrough developments by Jack Winters and Jack Saltz of Bell Laboratories [9]. They tried to send data from multiple users on the same frequency/time channel using multiple antennas both at the transmitter and receiver. Since then, several academics and engineers have made significant contributions in the field of MIMO. Now MIMO technology has aroused interest because of its possible applications in digital television, wireless local area networks, metropolitan area networks and mobile communication.

IV. SPECTRUM SENSING

A major challenge in cognitive radio is that the secondary users need to detect the presence of primary users in a licensed spectrum and quit the frequency band as quickly as possible if the corresponding primary radio emerges in order to avoid interference to primary users. This technique is called spectrum sensing. Spectrum sensing and estimation is the first step to implement Cognitive Radio system [5]. We can categorize spectrum sensing techniques into direct method, which is considered as frequency domain approach, where the estimation is carried out directly from signal and indirect method, which is known as time domain approach, where the estimation is performed using autocorrelation of the signal. Another way of categorizing the spectrum sensing and estimation methods is by making group into model based parametric method and period gram based nonparametric method.

a. Primary transmitter detection: In this case, the detection of primary users is performed based on the received signal at CR users. This approach includes matched filter (MF) based detection, energy based detection, covariance based detection, waveform based detection, cyclostationary based detection, radio identification based detection and random Hough Transform based detection.

b. Cooperative and collaborative detection: In this approach, the primary signals for spectrum opportunities are detected reliably by interacting or cooperating with other users, and the method can be implemented as either centralized access to spectrum coordinated by a spectrum server or distributed approach implied by the spectrum load smoothing algorithm or external detection.

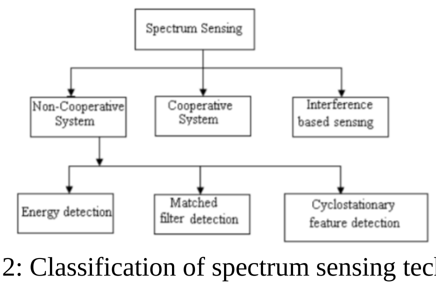

Figure 2: Classification of spectrum sensing techniques

Figure 2 shows the detailed classification of spectrum Sensing techniques. They are broadly classified into three main types, transmitter detection or non-cooperative sensing, cooperative sensing and interference based sensing. Transmitter detection technique is further classified into energy detection, matched filter detection and cyclostationary feature detection [12].

V. PROPOSED METHODOLOGY

Based on the spectrum sensing schemes, the cognitive radio is proposed to reduce the computational complexity in MIMO-OFDM system. On the one hand, apply thematching filter algorithm in a different antenna, and employ the linear property of inverse Fast Fourier transform (IFFT) to increase the number of candidate sequences so as to achieve better SNRand lower MSE performance.

VI. EXPECTED OUTCOME

This research project expects to have the following outcomes by the end of the project.

- The MSE of the wireless communication can also be reduced by using cognitive radio technique.
- Analysis of the 2×1, 2×2, 4×1 and 4×4 MIMO-OFDM system using cognitive radio network for wireless communication.
- Analysis of the signal to noise ratio (SNR) for the different sub-carrier system.
- Analysis of the primary and secondary user used in MIMO-OFDM system and achieved better result.

VII. CONCLUSION

We have observed the energy-efficient resource allocation in an OFDM-based CR network is an important function for green communication method. The proposed design is broad also it covers many possible restraints, focusing an intractable mixed integer programming problem. In this design, we accomplish a set of identical conversions by evaluating the define complication thoroughly, redesigning it into a convex optimization problem that can be determined by standard optimization procedure. Moreover, we evolve a dynamic algorithm to work out the (near) optimal result by employing its certain structure to update Newton step in an innovative approach, minimizing the computation complexity dramatically and making its applications possible. The numerical results show that our resource allocation proposal can achieve near optimal energy efficiency, hence the algorithm developed in this paper converges quickly and stably. Imperfect channel state information case can be considered as a future extension. By adopting MIMO we are enhancing the energy efficiency by which the durability of device increases and power consumption is decreases which are very important in the field of Telecommunication Industry.

REFERENCES

[1] Abdullah Yaqot and Peter Adam Hoeher, “Efficient Resource Allocation in Cognitive Networks”, IEEE Transactions on Vehicular Technology, Vol. 66, No. 07, July 2017.

[2] Danda B. Rawat, “Evaluation Performance of Cognitive Radio Users in MIMO-OFDM based Wireless Networks”, IEEE Transaction of Wireless System, IEEE 2916.

[3] Shan Jin and Xi Zhang, “Compressive Spectrum Sensing for MIMO-OFDM Based Cognitive Radio Networks”, 2015 IEEE Wireless Communications and Networking Conference (WCNC), Applications, and Business, Vol. 27, No. 2, pp. 567-572, 2015.

[4] Xuan Fu, Ying Zhut, Jian Yang, Yifan Zhang and Zhiyong Feng, “Simplified Cyclostationary Detector usingCompressed Sensing”, 2015 IEEE Wireless Communications and Networking Conference (WCNC 2015) - Track 1: PHY and Fundamentals.

[5] Eric Rebeiz, Varun Jain, DanijelaCabric, “Cyclostationary-Based Low Complexity WidebandSpectrum Sensing using Compressive Sampling”, IEEE ICC 2012 - Cognitive Radio and Networks Symposium.

[6] Maan Singh and Vijay Kumar, “Investigation of PAPR Reduction in MIMO-OFDM System using PTS and SLM Techniques”, International of Science and Research (IJSR), Vol. 3, No. 03, pp. 524-529, March 2014.

[7] Muhammet Nuri Seyman and NecmiTaspmar, "Channel estimation based on neural network in space time block coded MIMO-OFDM system", Digital Signal Processing, Vol. 23, No.1, pp. 275-280, Jan. 2013.

[8] Li Mei, Wang Xiang, Zhang Xiaoming, JiaKe. "RLS and its improved algorithms in MIMO-OFDM System", International Journal of Modelling, Identification and Control, Vol. 16, No. 3, pp. 246-250, Jul. 2012.

[9] P. Mukunthan and, P Dananjayan," PAPR Reduction based on a Modified PTS with Interleaving and Pulse Shaping method for STBC MIMO-OFDM System", IEEE International Conference Coimbatore, July 2012.

[10] Wei Jiang and Daoben Li, “Convolutional Multi-code Multiplexing for OFDM Systems”, Beijing University of Posts and Telecommunications Beijing, pp. 6432-6439, IEEE 2012.

[11] Yuan Jinsha, and Shi Hongmei, “A Modified Symbol Timing Synchronization Algorithm for WiMAX OFDM Systems”, 2008 IEEE Pacific-Asia Workshop on Computational Intelligence and Industrial Application.

[12] L. Yang, K. K. Soo, S. li, and Y. M. SU, “PAPR Reduction Using Low Complexity PTS to Construct of OFDM Signals Without Side Information”, IEEE Transactions on Broadcasting, Vol. 57, No. 2, pp. 4532-4539, June 2011.

[13] Chin-Liang Wang and Shun-Sheng Wang† and Hsiao-Ling Chang, “A Low-Complexity SLM Based PAPR Reduction Scheme for SFBC MIMO-OFDM Systems”, International Conference on Wireless Communication, pp. 345-352, 2011 IEEE.

[14] K. Y. Cho, B. S. Choi, Y. Takushima, and Y. C. Chung, B25.78-Gb/s operation of RSOA for next-generation optical access networks,[IEEE Photon. Technol. Lett., vol. 23, no. 8, pp. 495–497, Apr. 2011.