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Energy Efficient local spectrum sensing algorithm to detect OFDM based P.U Detection in Cognitive Radios

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Abstract—Cognitive radio is used for improving the radio electromagnetic spectrum. The Cognitive Radio determines the occupancy of frequency spectrum. Spectrum sensing forms a key front end block to study optimal detection method as modified energy detection (MED) and equal gain detection (EGD).The main study is to ease constraints of bandwidth and utilization techniques of spectral holes in unutilized spectrum used for instantaneous communication by secondary users. This procedure is to improve conventional EBSS technique by combining with statistical Principal Component Analysis (PCA) .It is studied to coorelate the ratios of decomposed signal space power and noise space power. The aim of this research is to analyze Energy Efficient local spectrum sensing algorithm to detect OFDM based P.U Detection in COGNITIVE RADIOS.

Keywords— Cognitive Radio; Spectrum sensing; Threshold energy; Orthogonal frequency division multiplexing.

I. INTRODUCTION

The emerging wireless multimedia applications are leading to an insatiable demand for radio spectrum. The current fixed frequency allocation strategy worked well in the past providing an optimal solution by avoiding interference among users. However, steadily growing number of wireless subscribers and operators, fixed assigning the radio spectrum is proving a hurdle in the deployment of new wireless services. As a result, several spectrum regulatory authorities around the world carried out studies on current spectrum scarcity with an aim to optimally manage available radio spectrum interestingly, these studies revealed that a large portion of assigned spectrum is either not used at all or only sparsely utilized, for significant periods of time. According to Federal Communications Commission (FCC) [1], spectrum utilization varies from 15% to 85% with wide variance in time and space. It was concluded that the root cause of current spectrum scarcity is not the physical shortage of spectrum rather the inefficient fixed spectrum allocation. This finding opened doors to the new communication paradigm of sharing the under-utilized radio spectrum through dynamic and opportunistic spectrum access (DOSA) [2].

The technology enabling un-licensed users to dynamically and opportunistically access the licensed spectrum, without affecting the existing users with legacy rights , is cognitive radio (CR) technology. The key component of technology is its sensing ability that it ultimately adapting continuously for the changing radio operating environment , where incumbents of frequency bands are primary users (PU) and secondary users (SU) are reserved for low-priority un-licensed users equipped with cognitive capability to exploit the spectrum without affecting the operation of PU. The most crucial task of SU is to identify available frequency bands across multiple dimensions like time, space, frequency, angle and code efficiently to exploit them dynamically by updating its transmission parameters under the stringent requirement of avoiding interference between licensed users of that spectrum. To accomplish, secondary users rely on robust and efficient spectrum sensing (SS) by identifying vacant frequency bands under uncertain radio frequency (RF) environment to detect primary users with high probability of detection so that incumbents become active in the band of interest [3].

II. COGNITIVE RADIO

Cognitive radio is an evolution of software defined radio (SDR) formally defined by FCC [4] as
‘‘Cognitive Radio’’ is a radio that can change its transmitter parameters based on interaction with the environment in which it operates.

The ultimate objective of CR is utilizing the unused spectrum. In essence which means that CR introduces intelligence to conventional radio such that it searches for a spectrum hole defined as ‘‘a licensed frequency band not being used by an incumbent at that time within a selected area’’.The most of the spectrum is assigned to PUs with legacy rights, the important point is sharing of licensed spectrum without any harmful interference to PUs. The main functionality of CR is tracking of spectrum hole [5]. Spectrum usage opportunity is exploited by CR for no spectrum activity is detected. If the band is re-acquired by PU, CR being low-priority secondary user either vacate the band or adjust the transmission parameters to accommodate the PU or if available/possible, shift to another spectrum hole.

III. COGNITIVE CHARACTERISTICS

Cognitive functionality described above have two main characteristics of CR as cognitive capability and reconfigurability. Cognitive capability refers the ability of radio technology to interact with radio environment in real time to identify **and** scavenge ''un-occupied'' licensed spectrum bands called spectrum holes or white spaces [6]. The observations published by FCC in [1], categorizes spectrum holes as : temporal spectrum holes and spatial spectrum holes. This defines two secondary communication schemes [7] of exploiting spectrum opportunity in time and space domain which are depicted in Fig. 1(a) and (b) respectively.

A temporal spectrum hole occurs when no primary transmission is detected over the scanned frequency band for a reasonable amount of time and frequency band is available for secondary communication . A spatial spectrum hole is generated when primary transmissions are confined for certain area as shown in Fig. 1(b) and hence this frequency band is available for secondary communication (may be in the same time slot) well outside the coverage area of PU to avoid any possible interference with primary communication. The secondary transmission over the spatially available licensed spectrum is allowed if it remains transparent to presumably nearby primary receiver. There stringent requirement on SU that able to successfully detect PU at any place where secondary communication may cause interference to primary transmission. The protection area of PU is defined wherein SU must be able to detect any PU activity to avoid harmful interference with primary receiver Dmin apart from SU [8,9]. The cognitive capability is not limited to only monitoring power in some frequency band rather it demands. multidimensional spectral awareness [10]. This means that CR should be able to reconfigure its communication parameters on the fly in order to adapt its dynamic radio environment, calling for the reconfigurability characteristics of Cognitive radio.

IV. KEY TO COGNITION

The key concept in CR is the provision of opportunistic and dynamic spectrum access of licensed frequency bands to unlicensed users. Hence, the main functionality of CR lies in efficient spectrum sensing so that whenever an opportunity of unused spectrum band is identified, CR may make use of it. This paper aims at exploring various dimensions of spectrum sensing with an aim to review ongoing and emerging trends in SS and compare different SS techniques to identify room for potential research opportunities in this field.`

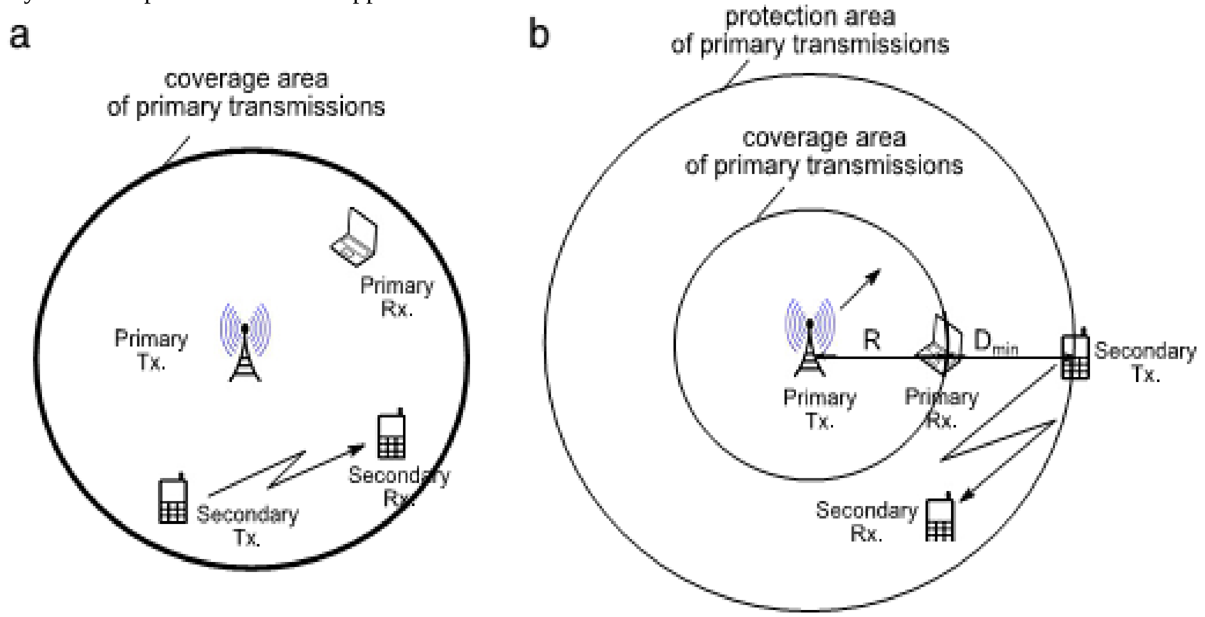

Fig. 1

V. SPECTRUM SENSING

SS is the task of obtaining spectrum occupancy information. Three main approaches are adopted to obtain this spectrum occupancy knowledge. They are:

1. Spectrum sensing using geolocation and database [11,12].
2. Spectrum sensing by listening to cognitive pilot channel (CPC) or PU beacons [13,14].
3. Local spectrum sensing at CR [15,16].

The most efficient approach to identify spectrum opportunity with low infrastructure requirement is to detect primary receiver within operative range of CR.

It is not feasible as CR cannot locate PU receiver and hence spectrum sensing techniques usually rely on primary transmitter detection. On looking the details of spectrum sensing methods to summarize the typical grouping of SS schemes in Fig. 2 and highlight characteristic features of these sensing approaches : Typically, spectrum sensing is classified into three main detection approaches.

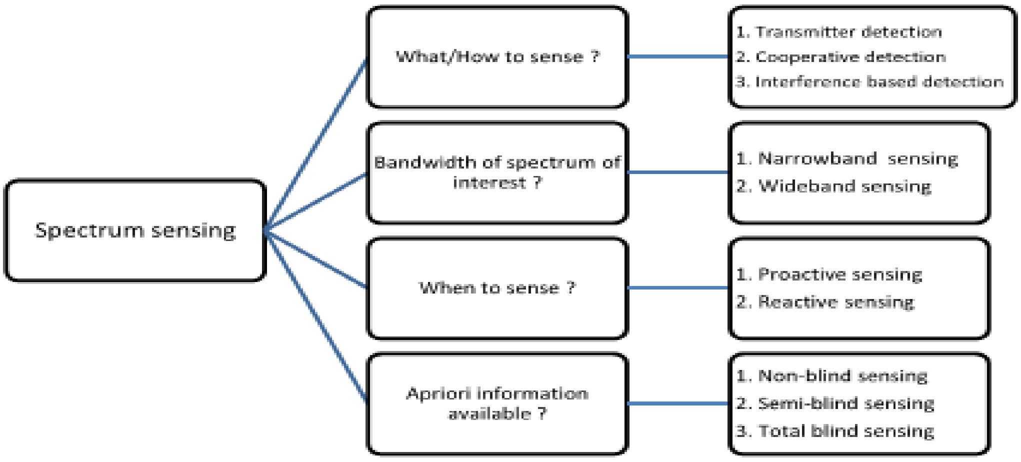

Fig. 2

In non-cooperative primary transmitter detection approach, CR makes a decision about the presence or absence of PU on its local observations of primary transmitter signal. In comparison, cooperative detection refers to transmitter detection based SS methods where multiple CRs cooperate in a centralized or decentralized manner to decide about the spectrum hole. Each cooperating node in cognitive radio oriented wireless network (CROWN) may apply any sensing method locally and then share its raw/refined sensing information with other node(s), depending on a selected cooperation strategy. A priori information required for PU detection is another important criterion upon which different SS methods are classified. In this category, different transmitter detection based sensing techniques are categorized as non-blind, semi-blind or total blind. Non-blind schemes require primary signal signatures as well as noise power estimation to reliably detect PU. Semi-blind schemes are relaxed in the sense that they need only noise variance estimate to detect a spectrum hole. However, most practical sensing techniques are generally total blind, requiring no information on source signal or noise power to determine PU activity. Fundamental to all these classifications is to detect presence or absence of PU signal. Here, we focus on transmitter detection sensing based on a non-cooperative and cooperative approach. Fig. 3 illustrates the SS classification where different borders are used to group representative transmitter detection techniques as non-blind, semi-blind and blind schemes .

VI. RELATED STUDY

Gerald Q.Macquire[16] proposed Cognitive Radios making software as an emerging platforms for multiband ,multimode personal communications systems having Radio etiquettes confining set of RF bands, air interfaces, protocols, spatial and temporal patterns that moderate the use of radio spectrum by enhancing the flexibility of Systems through RKRL of radio etiquettes,devices, software modules,propagation and networks that supports Automated Reasoning.

Simon Haykins [17] proposed Cognitive radio as the Brain empowered wireless communaication as approach for improving the utilization the radio electromagnetic spectrum.The cognitive radio, built on SDR is intelligent approach aware of its environment by addressing three cognitive tasks: Radio-scene analysis,Channel-state estimation and Predictive modeling and Transmit-power control and dynamic spectrum management.

Xiong Zhang [18] proposed Asynchronous Cooperative spectrum sensing in Cognitive Radios having users that can collaborated by performing spectrum sensing to detect primary users when sensing nodes suffer from fading, shadowing, and time-varying nature of wireless channels includes the severe degradation of the sensing performance to propose asynchronous cooperative spectrum sensing method which can exploit the user's SNR to enhance the sensing performance.

Li Cui[19] proposed Cooperative Spectrum sensing in Cognitive Radios considered the problem of reliability of unlicensed users for cooperative by analyzing the Huffman encoding algorithm by deriving close-form expressions for the average sending bits for each unlicensed user for cooperation and expression for the probability of the detection and the false-alarm for the novel cooperative spectrum sensing scheme.

Gokhan Memik[20] proposed Energy detection using Estimated Noise Variance for Spectrum Sensing to analyse modelling to evaluate the statistical performance of the energy detection by demonstrating the effectiveness of analytical model by showing to set the appropriate threshold like more spectrum sharing with combination of spectrum sharing method.

ChenGuo[21] proposed Agility Improvements by Censor-Based Cooperative Spectrum sensing to improve the performance of spectrum sensing by limiting control of channel bandwidth and delay of sensing would impact the spectrum sensing performance by increasing the cognitive users which signifies that agilitygain improves without the loss of spectrum sensing reliability with improved censor-based scheme proposed to reduce spectrum utilization loss.

Pan Jianguo[22] proposed energy detection technique for optimizing performance with impact of noise uncertainty on detection probability study by dealing hidden terminal problem with local spectrum sensing in wireless signal detection with distributed M-cooperative sensing scheme proposed by careful analysis showing benefits by increasing the agilities with small tradeoffs between the detection probability and false alarm probability schemes improve the spectrum sensing ability greatly in low SNR situations.

Anirudh M. Rao[23] proposed to ease the constraint of additional bandwidth, utilization of the existing system as Cognitive Radio defines new technique of spectral holes in unutilized spectrum used for instantaneous communication by secondary users which defines the procedure to improve the conventional EBSS technique by combining with the statistical Principal Component Analysis (PCA) by coorelating the ratio of decomposed signal space power and noise space power by equating actual SNR having validated combination of PCA and EBSS.

Asrar U. H. Sheikh[24] proposed networks by addressing the current spectrum scarcity problem with dynamic and opportunistic spectrum access by enabling technology for Cognitive Radio Oriented Wireless Network (CROWN) having low-priority secondary users (CRs) allowed to communicate over licensed frequency bands by highlighting fundamental challenges in getting multi-dimensional spectrum awareness under practical constraints and provide viable solutions and limitations of both transmitter detection based non-cooperative spectrum sensing techniques and cooperative sensing strategies superimposed.

Yifei Huang[25] proposed optimal detection method with reduced-complexity methods, modified energy detection (MED) and equal gain detection (EGD) under low signal-to-noise ratio, the proposed optimal detection and EGD achieve better performance for energy detection when signal temporal correlation information is exploited by revealing the multipath tap correlation having either constructive or destructive effects for spectrum sensing by proposing EGD as practical technique for reliable spectrum sensing over multipath fading channels for optimal performance.

VII. CONCLUSION

In Wireless technology, it is found that spectrum scarcity is the main issue.Cognitive radio approaches the software radio is a potential to personalize services is a process of modifying radio etiquettes.The detection for spectrum sensing using energy detection method affect the performance of spectrum sensing. To deal with the hidden terminal problem and the local spectrum sensing, OFDM Energy Efficient local spectrum sensing algorithm is proposed for P.U Detection schemes and its benefits increases the agility of cognitive radio systems.

REFERENCES

[1] FCC, ET Docket No. 03-222 Notice of proposed rule making and order, December 2003.
[2] I.F. Akyildiz, W.Y. Lee, M.C. Vuran, S. Mohanty, NeXt generation/dynamic spectrum access/cognitive radio wireless networks: a survey, Journal of Computer Networks 50 (13) (2006) 2127–2159.
[3] R. Umar, A.U.H. Sheikh, Spectrum access and sharing for cognitive radio, in: Developments in Wireless Network Prototyping, Design and Deployment: Future Generations, IGI Global, 2012, pp. 241–271 (Chapter 12).
[4] FCC, ET Docket No. 02-135 Notice of proposed rule making and order, November 2002.
[5] R. Tandra, S.M. Mishra, A. Sahai, What is a spectrum hole and what does it take to recognize one? Proceedings of the IEEE 97 (5) (2009) 824–848.
[6] S. Haykin, Cognitive radio: brain-empowered wireless communications, IEEE Transactions on Communications 23 (2) (2005) 201–220.
[7] J. Ma, G.Y. Li, B.H. Juang, Signal processing in cognitive radio, Proceedings of the IEEE 97 (5) (2009) 805 823.
[8] A. Sahai, N. Hoven, R. Tandra, Some fundamental limits in cognitive radio, in: Allerton Conference on Communications, Control and Computing, Urbana, October 2004.
[9] A. Ghasemi, E.S. Sousa, Spectrum sensing in cognitive radio networks: requirements, challenges and design trade-offs, IEEE Communications Magazine 46 (4) (2008) 32–39.
[10] T. Yucek, H. Arslan, A survey of spectrum sensing algorithms for cognitive radio applications, IEEE Communications Surveys and Tutorials 11 (1) (2009) First quarter
[11] S.J. Shellhammer, A comparison of geo-location and spectrum sensing in cognitive radio, in: 18th International Conference on Computer Communications and Networks, ICCCN 09, August 2009.
[12] Y. Zhao, L. Morales, J. Gaeddert, K.K. Bae, J.-S. Um, J.H. Reed, Applying radio environment maps to cognitive wireless regional area networks, in: 2nd IEEE International Symposium on Dynamic Spectrum Access Networks, DySPAN'07, 17–20 April 2007, pp. 115–118.
[13] A.P. Hulbert, Spectrum sharing through beacons, in: 16th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, PIMRC'05, September 2005, pp. 989–993.
[14] M. Derakhshani, T. Le-Ngoc, Aggregate interference and capacityoutage analysis in a cognitive radio network, IEEE Transactions on Vehicular Technology 61 (1) (2012) 196–207.
[15] E. Axell, G. Leus, E.G. Larsson, Overview of spectrum sensing for cognitive radio, in: 2nd International Workshop on Cognitive Information Processing, 2010.

[16] Cognitive Radios : Making Software more personal , IEEE Pcrsonal Communications Auguat 1999.

[17] Cognitive Radio: Brain-Empowered Wireless Communications , IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, VOL. 23, NO. 2, FEBRUARY 2005.

[18] Asynchronous Cooperative Spectrum Sensing in Cognitive Radio , ICSP2008 Proceedings.

[19] Cooperative spectrum sensing in cognitive radio systems, 2008 Congress on Image and Signal Processing.

[20] Energy Detection using Estimated Noise Variance for Spectrum Sensing in Cognitive Radio Networks , IEEE Communications Society subject matter experts for publication in the WCNC 2008 proceedings.

[21] Energy Detection Based Spectrum Sensing for Cognitive Radios in Noise of Uncertain Power, 2008 International Symposium on Communications and Information Technologies (ISCIT 2008).

[22] Agility Improvements by Censor-Based Cooperative Spectrum Sensing in Cognitive Radio Networks ,This work is sponsored by Nokia, and in part by the National Basic Research Program of China (973 Program) under grant no. 2007CB310602

[23] Energy-Detection Based Spectrum Sensing for Cognitive Radio, This work is supported by foundation for development from the education committee of Shanghai (No. 05AZ46), and by the foundation of education committee of Shanghai for outstanding young teachers.

[24] Cognitive Radio Oriented Wireless Networks:Challenges and Solutions, Wireless Broadband Communication Research Group Electrical Engineering Department King Fahd University of Petroleum & Minerals, Dhahran 31261, Saudi Arabia,University of Engineering and Technology, Lahore 54890, Pakistan (on study leave).

[25] Detection of Temporally Correlated Signals over Multipath Fading Channels , IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS, VOL. 12, NO. 3, MARCH 2013

