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Performance Enhancement of Asynchronous Cooperative Spectrum Sensing

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Abstract - In cognitive radio networks, the users are supposed to perform spectrum sensing with mush more accuracy to detect the more and more users. But in practice due to fading, shadowing etc., a long observation period of time is needed to make decisions based on detection which results in degradation of sensing performance. In this paper, we presented a new approach called Cuckoo Search for asynchronous cooperative spectrum sensing which results in enhanced sensing performance. Simulation results show that the detection time is reduced without sensing performance degradation compared to Asynchronous cooperative spectrum sensing (ACSS) and conventional cooperative spectrum sensing (CSS).

Keywords – Cuckoo Search, Probability of False Alarm, Probability of detection, Spectrum Sensing Performance.

I. INTRODUCTION

The available electromagnetic radio spectrum is a limited natural resource and getting crowded day by day due to increase in wireless devices and applications. It has been also found that the allocated spectrum is underutilized because of the static allocation of the spectrum. Also, the conventional approach to spectrum management is very inflexible in the sense that each wireless operator is assigned an exclusive license to operate in a defined frequency band. With most of the useful radio spectrum which has been already allocated, it is difficult to search for vacant bands to either deploy new services or to enhance existing ones. The issue of spectrum underutilization in wireless communication can be solved in a better way using *Cognitive radio (CR)* technology. Cognitive radios are designed to provide highly reliable communication for all users of the network, anywhere needed and to facilitate effective utilization of the radio spectrum.

1.1 CR FEATURES

The unlicensed user leaves the spectrum at once the licensed users of that spectrum access it. A spectrum sensing is a key feature in CR technology. To check for the unused bands two methods are used, one is database oriented sensing and spectrum sensing oriented method. Generally first method is widely used in TVWS (Television White Space), in which the database contains the information about the primary user's location adopted by FCC, as this is used to detect the spectrum usage of licensed users by accessing database. The spectrum sensing is lending the un/underutilized portion of radio spectrum from the licensed users without causing interference to primary users. The idle frequency bands can be detected by spectrum sensing.

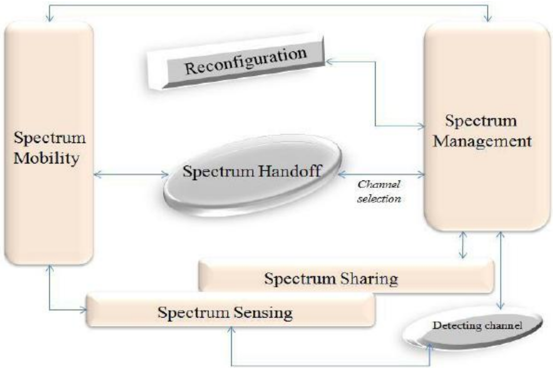
1.2 FUNCTIONS OF CR

i) Spectrum Management- As per the needs of the secondary users the best communication channel is provided to them. This scenario shows the improper use of spectrum. Most of the licensed bands are not utilized properly, so the resources are wasted at one side and other side lack of resources for unlicensed users. Both the conditions must b

ii) Spectrum Mobility - concept says when SU accessing the licensed spectrum, if it finds the primary users is back to their channel, it should immediately leave the channel without creating any disturbance or interference to the PU. Pre-empting the SUs access to the licensed channel may affect their performance, so the SU must be dynamically switched on to another available spectrum hole, which is called spectrum handoff. In some cases unlicensed bands may lose its quality.

iii) Spectrum Sharing – several users can share or co-ordinate the same channel, also for selecting the required channel and power allocation. Co-existence between licensed users occurs; this remains a challenge in sharing spectrum.

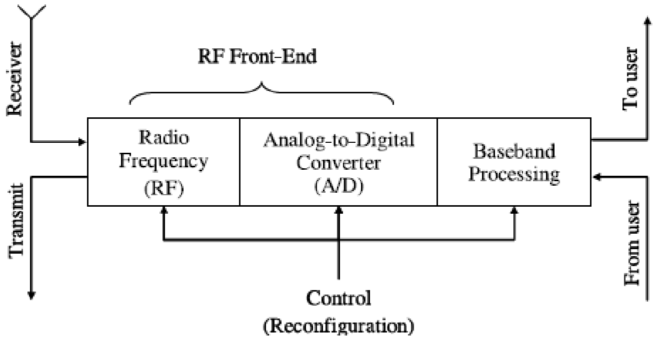
iv) Spectrum Decision – Based on the user requirement the decision is taken to select the particular band which provides better communication channel from available channels which are not in use currently. Selection of channel is based on current transmission, and also on Quality of Service requirements.



CR Functionality

1.3 PHYSICAL ARCHITECTURE OF CR

A generic architecture of a cognitive radio transceiver is shown. The main components of a cognitive radio transceiver are the radio front-end and the baseband processing unit. Every component can be reconfigured via a control bus to adapt to the time-varying RF environment. In the RF (radio frequency) front-end, the received signal is amplified, mixed and then A/D converted.



II. RELATED WORK

Xueqiang Zheng et.al [1], the author considers the problem of use the reliability of unlicensed users for cooperative spectrum sensing in cognitive radio systems by analyzing the Huffman encoding algorithm. He present a cooperative spectrum sensing algorithm in cognitive radio systems. He drive the 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. Finally, paper show through numerical results the potential cooperative spectrum sensing performance improvement with using the reliability of unlicensed users.

Xiong Zhnag et.al [2], In cognitive radio networks, the CR users can be collaborated to perform spectrum sensing so as to detect the primary user more accurately. However, when the sensing nodes suffer from fading, shadowing, and time-varying nature of wireless channels, a long observation time for all of the nodes is needed to make decisions and forward the results to fusion center, which induce the severe degradation of the sensing performance. In this paper, the author propose an asynchronous cooperative spectrum sensing method, in which the cognitive radio user with high SNR finishes the detection earlier than the one with low SNR, and the fusion center makes the final decision depending on the earliest local decision. The proposed method can exploit the user's SNR diversity so that the sensing performance can be enhanced. Simulation results show that the detection time is reduced significantly at the expense of a little sensing performance degradation compared to the conventional cooperative spectrum sensing.

Asma Amraoui et.al [3], the author focused on the increasing demand for wireless communication introduces efficient spectrum utilization challenge. To address this challenge, cognitive radio (CR) is emerged as the key technology; which enables opportunistic access to the spectrum. CR is a form of wireless communication in which a transceiver can intelligently detect which communication channels are in use and which are not, and instantly move into vacant channels while avoiding occupied ones. This optimizes the use of available radio-frequency (RF) spectrum while minimizing interference to other users. In this paper, the author present a state of the art on the use of Multi Agent Systems (MAS) for spectrum access using cooperation and competition to solve the problem of spectrum allocation and ensure better management. Then paper propose a new approach which uses the CR for improving wireless communication for a single cognitive radio mobile terminal (CRMT).

Jorg Lotze et.al [4], according to the author, Cognitive radio is a promising technology for fulfilling the spectrum and service requirements of future wireless communication systems. Real experimentation is a key factor for driving research forward. However, the experimentation testbeds available today are cumbersome to use, require detailed platform knowledge, and often lack high level design methods and tools. In this paper we propose a novel cognitive radio design technique, based on a high-level model which is implementation independent, supports design-time correctness checks, and clearly defines the underlying execution semantics. A radio designed using this technique can be synthesised to various real radio platforms automatically; detailed knowledge of the target platform is not required. The proposed technique therefore simplifies cognitive radio design and implementation significantly, allowing researchers to validate ideas in experiments without extensive engineering effort. One example target platform is proposed, comprising software and reconfigurable hardware. The design technique is demonstrated for this platform through the development of two realistic cognitive radio applications.

Mansi Subhedar et.al [5], the author focused on the growing demand of wireless applications has put a lot of constraints on the usage of available radio spectrum which is limited and precious resource. However, a fixed spectrum assignment has lead to under utilisation of spectrum as a great portion of licensed spectrum is not effectively utilised. Cognitive radio is a promising technology which provides a novel way to improve utilization efficiency of available electromagnetic spectrum. Spectrum sensing helps to detect the spectrum holes (underutilised bands of the spectrum) providing high spectral resolution capability. In this paper, survey of spectrum sensing techniques is presented. The challenges and issues involved in implementation of spectrum sensing techniques are discussed in detail giving comparative study of various methodologies.

Abhiraami R et.al [6], In this Modernistic World folks want everything compact and mobile. As the wireless devices dominate the market, the necessity of wireless network and wireless communication has been increased. The Regulations of FCC (Federal Communications Commission) allocates 2.4 GHz to ISM band. It is used by major part of the population because technologies like Zigbee, Bluetooth, Wi-Fi/802.11 and etc use this unlicensed band. As a result we are running out of spectrum. Shortage in the unlicensed band must be alleviated. The promising solution is Cognitive Radio (CR). In this paper, CR and its features are reviewed in detail. Basics of Software Defined Radio (SDR) and related technologies were discussed. This paper gives the overview about SDR and describes the functions and importance of cognitive Radio. Also the key research areas and innovative works on Dynamic Spectrum Access (DSA) have been analyzed. A new idea of integrating the existing strategies to effectively utilize the spectrum is proposed.

Ian F. Akyildiz et.al [7], Today's wireless networks are characterized by a fixed spectrum assignment policy. However, a large portion of the assigned spectrum is used sporadically and geographical variations in the utilization of assigned spectrum ranges from 15% to 85% with a high variance in time. The limited available spectrum and the inefficiency in the spectrum usage necessitate a new communication paradigm to exploit the existing wireless spectrum opportunistically. This new networking paradigm is referred to as NeXt Generation (xG) Networks as well as Dynamic Spectrum Access (DSA) and cognitive radio networks. The term xG networks is used throughout the paper. The novel functionalities and current research challenges of the xG networks are explained in detail. More specifically, a brief overview of the cognitive radio technology is provided and the xG network architecture is introduced. Moreover, the xG network functions such as spectrum management, spectrum mobility and spectrum sharing are explained in detail. The influence of these functions on the performance of the upper layer protocols such as routing and transport are investigated and open research issues in these areas are also outlined. Finally, the cross-layer design challenges in xG networks are discussed.

III. PROPOSED WORK

To formulate a new Meta – Heuristic algorithm called Cuckoo search (CS), for solving optimization problems. Cuckoo Search is based on idealized rules such as breeding behavior and thus can be applied for various optimization problems. CS is based on three idealized rules:

a. Each cuckoo lays one egg at a time and dumps its egg in a randomly chosen nest.

b. The best nests with high quality of eggs will carry over to the next generation.

c. The number of available hosts nests is fixed and the egg laid by a cuckoo is discovered by the host bird with a probability of P (a) = (0, 1).

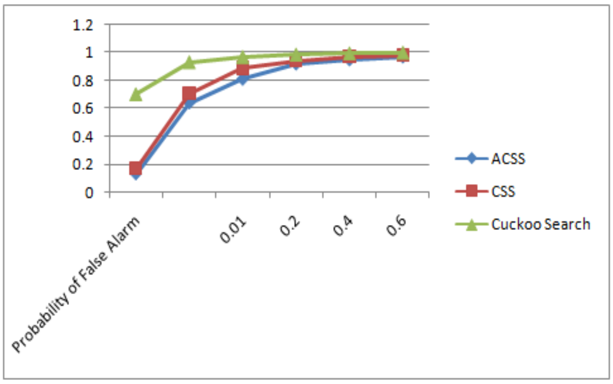
IV. RESULTS

In this paper, we present some simulation results demonstrating the performance of asynchronous cooperative spectrum sensing using Cuckoo search technique. The work is implemented using MATLAB version 2010. As a signal of interest, we take a 64QAM modulated signal sampled at frequency Fe=50Fs, where Fs=800Kbpsis the symbol frequency.

The number of CR users ranges from 5 to 20, and the SNR of the CR users are randomly distributed within [0 10]dB. We can set the observation time according to the graph, T1=0.01MS, T2=0.2MS, T3=0.4ms, T4=0.6ms, T5=0.8ms and T6=1ms.

Table showing comparison

Probability of False Alarm	Probability of detection		
	ACSS	CSS	Cuckoo Search
0.01	0.13	0.17	0.7045
0.2	0.64	0.71	0.9321
0.4	0.81	0.89	0.9693
0.6	0.92	0.94	0.9859
0.8	0.95	0.97	0.9952
1	0.97	0.98	0.9998



Graph showing the performance

V. CONCLUSION

Here, we have introduced a new technique named Cuckoo Search for Asynchronous cooperative spectrum sensing, targeting at improving the performance of detection of spectrum sensing in Cognitive Radio Networks. Simulation results show that the probability of detection of the proposed method is increased as compared to the existing Asynchronous cooperative spectrum sensing (ACSS) and conventional cooperative spectrum sensing (CSS).

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