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Collaborative Spectrum Sensing using Cognitive Adaptive MAC Protocol for CRN

S.Esakki Rajavel[1], Bhavani.P[2], Anitha.M[3], Azhagu Avudai Nayaki.G[4]
[1]Assistant Professor, Department of Electronics and Communication, Francis Xavier Engineering College, Vannarpettai, Tirunelveli, Tamilnadu 627003, India.
[2-4] UG Scholar, Department of Electronics and Communication Engineering, Francis Xavier Engineering College. Vannarpettai, Tirunelveli, Tamilnadu -627003, India.
[1]rajavel019@gmail.com,[2]bhavanijanu12@gmail.com, [3]anitha040296@gmail.com
[4]azhaguavudainayaki@gmail.com

Abstract: The high energy efficiency for cognitive sensor network (CSN) has been widely studied for supporting various applications in military and civil fields. By identifying time fraction, local detection threshold, and the number of cognitive sensors, we discuss some design considerations for a cluster-based collaborative spectrum sensing scheme. We formulate the optimization problem to maximize energy efficiency of CSN under a collision constraint and false alarm probability constraint. In order to overcome the problem of finding the optimal detection threshold when k-out-of-M fusion rule is used by the sink node (SN), we design a fictitious cognitive sensor (FCS), which has the same sensing performance as SN. The process for finding the optimal local detection threshold can be converted into the process for searching an optimal received SNR of FCS. Theoretical analysis shows that there exists a unique time fraction to maximize the energy efficiency. Finally our theoretical analysis is verified through numeric simulations. The above process is simulated in Network Simulator version 2 (NS 2).

Keywords: Cognitive sensor network, collaborative spectrum sensing, Energy Efficiency, Clustering, k- out-of M Rule.

I. Introduction

One of the typical application scenarios for a CSN is to monitor the spectrum usage state of wireless devices at a specific time and/or in a specific area. In order to improve spectral efficiency, CSs are permitted to access the idle licensed frequency bands without causing any harmful interference to primary users (PUs). Because of a deep fading and shadowing effects, collaborative negative spectrum sensing is often used to enhance sensing performance at cost of increased overhead traffic, energy consumption, and computational complexity. Energy efficiency, which is defined as the average throughput per Joule of energy, is an important metric to measure the network performance. Research on the collaborative spectrum sensing under energy constrained have become important topics for future wireless communication networks. Some recent works studies have focused on optimizing the sensing parameters for achieving the better sensing performance. Sensing duration, transmission power. In this letter, we formulate the optimization problem to maximize energy efficiency of CSN under the collision constraint and false alarm probability constraint. In order to improve practicality of our proposed scheme in the actual application, we consider the case that the received power levels of CSs are different. By constructing a FCS, we convert the process for finding the optimal local detection threshold into the process for searching an optimal received SNR of FCS.

II. System Model

We consider a centralized CSN that consists of one secondary SN and N homogeneous CSs, which are randomly located around a primary network with a licensed frequency band. In order to avoid blocking the

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normal communications of the CSs, the sensing, reporting, and transmission cannot occur simultaneously. The CSs are assumed to face the similar electromagnetic environment and operate in a time-slotted fashion. The CSs are grouped into a cluster based on their received power levels. The SN broadcasts the clustering result to all CSs through the control channel only once in the first slot. When the location, quantity, or monitoring frequency band of the CSs change, the CSs will be grouped into a new cluster.

A constant time slot duration *T* consists of the sensing duration *Ts*, reporting duration *Tr* and transmission duration *Tα*..The *α* is defined as the time fraction for sensing (referred as the ratio of sensing duration to *T* − *Tr*). Let *Td* = *T* − *Tr* ,*Ts* = *αTd* , *Tα* = *(*1 − *α) Td* and *T* = *Ts* + *ntr* + *Tα*,where *Tr* = *ntr* , *tr* is the reporting duration by each CS and *n (*1 ≤ *n* ≤ *N)* is the number of the clustered CSs. The selected CSs report the binary decisions on the activity of the PU to SN, which makes the final decision by using the "k-out-of-M" fusion rule and broadcasts the decision results to the CSs that need to access the licensed frequency band. If the sampling frequency is *fs* and energy detector is adopted by each CS to calculate the energy measurement over the sensing duration. The PU's transmitted signal is assumed to be an independent and identically distributed (*i id*) random process with zero mean and variance *σ*2 *x* . The noise is assumed to be a real-valued Gaussian variable with zero mean and variance *σ*2 *n* . Denote *π*0 to be the probability that the licensed frequency band is idle and *π*1 to be probability that the licensed frequency band is occupied by PU. *π*0 + *π*1 = 1, *π*0 and *π*1 are known to CSs based on the long-term measurements. The received signal power of the *i* -th *(i* = 1*,* 2*,* · · · *, N)* CS is *σ*2 *x,i*= |*hi* | *σ*2 *x*, where *hi* is the *i* -th CS channel gain from PU's transmitter to CS's transmitter. Then the received SNR at *i* -th CS's transmitter can be expressed as *γi* = *σ*2 *x,i/σ* 2*n.*

III. Problem Formulation

Define Ps , Pr , Pt as the power (Watt) consumed by each CS in sensing, reporting and transmission respectively. The average energy consumed by each CS within one time slot is expressed as Eav (α, ξ, n) = PsαTd + Pr tr +Pt (1 − α) Td* (1 − π1Qd − π0Q f). The energy efficiency η (α, ξ, n) = R(α,ξ,n) /Eav (α,ξ,n) , where the average throughput of the CSN can be defined as R (α, ξ, n) = (1−α)Td/T* C0(1 − Q f)π0. C0 is the volume of data transmission during the duration Tα. Our goal is to find α, ξ, and n such that the energy efficiency of the CSN is maximized under the collision and false alarm probability constraints. This optimization problem can be expressed.

IV. Solutions Of The Formulated Problem

1: **Initialize:**

2: For each $S_{i,j} \in S_i, 1 \leq j \leq |S_i|, a_{i,k} \in A, 1 \leq k \leq |A_i|$ ***do***

3: Initialize the Q-value representation mechanism $Q_i(S_{i,j}, a_{i,k})$

4: **end for**

5: Evaluate the starting state s=$S_{i,j} \in S_{i,j}, 1 \leq j \leq |S_i|$

6: **Learning:**

7: **Loop**

8: Generate a random number $r \in u[0,1]$

9: **if**(r$<\in$) **then**

10: Select action randomly

11: **else**

12: Select the action $a_{i,m} \in A_i$ characterized by the min (Q-value)

13: **end if**

14: Execute $a_{i,m}$

15: Receive an immediate capacity $C_{LAA,i}$ and cost C_i

16: Observe the next state $S_{i,l} \in S_i, 1 \leq l \leq |S_i|$

17: Update the Q-table entry as follows:

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$$Q_i\left(S_{i,j}, a_{i,k'}\right) \leftarrow (1-\alpha)Q_i\left(S_{i,j}, a_{i,k}\right)$$

S= $S_{i,l}$

end

Find one energy efficiency among N different values and its corresponding pair.

V. Simulation

The above theoretical analysis is verified and shown through numerical simulations in this section..Fig. 1 demonstrates the maximum energy consumption and the corresponding throughput *R* against *n* for different nodes. **From Fig. 1**, one can see that there exists an optimal *n*∗ such that the maximum energy efficiency can be achieved. Energy efficiency increases as *n* when n is small. When the *n* continues to increase above a certain value, more CSs participate in sensing and less time can be allocated to transmit data, then it will lead to the decreasing of energy efficiency .**Fig. 2** plots the effects the packet. of packet loss vs Time. It is the Communication is the difference between generated and received packet. **Fig.3** plots the effect of Throughput vs Time. It is the number of successfully received packets in a unit time ane it is represented in bps. **Fig.4** plots the effect of end to end delay vs Time. It is the difference between at which the sender generated the packet at which the receiver the receives

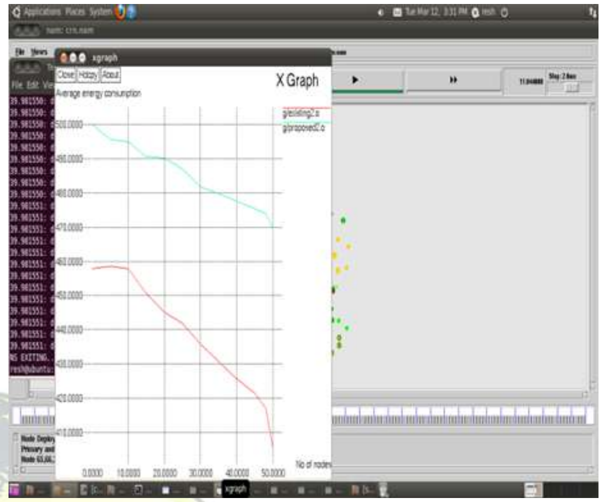

Fig.1

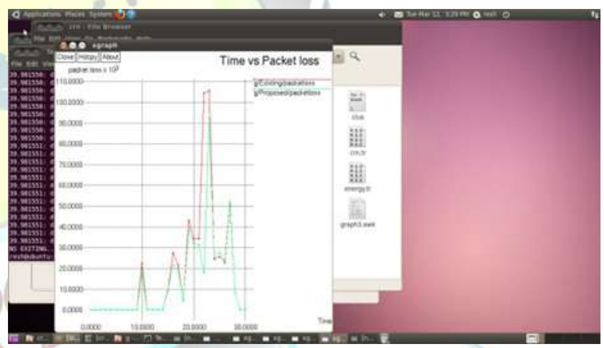

Fig.2

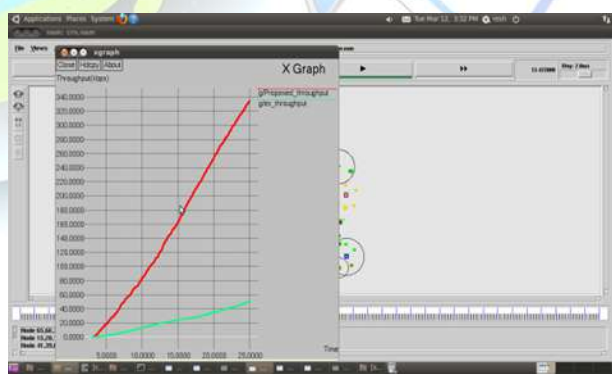

Fig.3

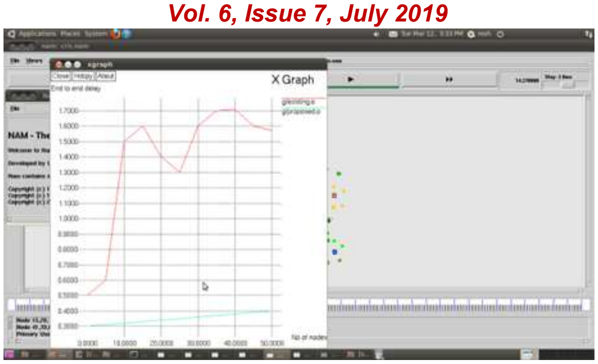

Fig.4

VI. CONCLUSION

In this Project CR has been realized to benefit the potential advantage of efficient spectrum utilization. This Project used a cluster based collaborative spectrum sensing with cooperative adhoc medium access protocol for spectrum sensing and efficient data transmission between secondary users. The Spectrum Sensing result is made by **K-out of M Rule.** Energy efficient spectrum sending is achieved by designing a new MAC protocol for CRSNs, which incorporates the dynamic spectrum access feature to provide opportunistic transmission while addressing the issue of power limitation of sensor nodes.

REFERENCES

[1]. F.F.Digham, M.S. Alouni and M.K.Simon "On the Energy detection or unknown signals over fading Channels" IEEE Trans. Commun, vol.55, no 1, pp.21-24, Jan 2007.

[2]. L.Tang, Y.Chen, E.L. Hines, and M.S. Alouini, "Effect of primary user traffic on sensing- throughput tradeoff for cognitive radios", IEEE Trans. Wireless Commun, vol.10, no.4, pp. 1063-1068, Apr-2011.

[3]. B. Hamdaoui and K.G. Shin, "OS-MAC: An Efficient MAC protocol for spectrum –agile wireless networks", IEEE Trans. Mobile Comput., vol 7,no 8,pp.915-930.Aug.2008

[4]. K.Chowdhury and I.Akyildiz, "OFDM based common control channel design for cognitive radio Ad-hoc networks", IEEE Trans Mobile Comput., vol 10, no.2,pp 228-238,Feb 2011.

[5]. G.A. Shah, V.C. Gungor and O.B. Akan, "A Cross layer Qos aware communication framework in cognitive radio sensor networks for smart grid applications, IEEE Trans .Ind Informat., vol.9,no.3, p.1477-1485,Aug 2013.

[6]. S.Maleki, A.Pandharipande, and G.Leus, "Energy-efficient distributed spectrum sensing for cognitive sensor networks," IEEE Sensors J.,vol. 11, no. 3, pp. 565–573, Mar. 2011.

[7]. K. Cicho´n, A. Kliks, and H. Bogucka, "Energy-efficient Cooperative Spectrum Sensing: A survey," IEEE Commun. Surveys Tuts., vol. 18,no. 3, pp. 1861–1886, 3rd Quart., 2016.

[8]. D. Huang, G. Kang, B. Wang, and H. Tian, "Energy-Efficient Spectrum Sensing Strategy in Cognitive Radio Networks," IEEE Commun. Lett., vol. 17, no. 5, pp. 928–931, May 2013

[9]. X. Liu, B. G. Evans, and K. Moessner, "Energy-Efficient Sensor Scheduling algorithm in Cognitive Radio Networks Employing Heterogeneous Sensors," IEEE Trans. Veh. Technol., vol. 64, no. 3, pp. 1243–1249, Mar. 2015.

[10]. H. Hu, H. Zhang, and Y.-C. Liang, "On the Spectrum and Energy Efficiency trade off in Cognitive Radio networks," IEEE Trans. Commun.,vol. 64, no. 2, pp. 490–501, Feb. 2016.

[11]. F. A. Awin, E. Abdel-Raheem, and M. Ahmadi, "Designing an Optimal Energy Efficient cluster-based Spectrum Sensing for Cognitive Radio Networks," IEEE Commun. Lett. vol. 20, no. 9, pp. 1884–1887, Sep. 2016.

[12]. F. A. Awin, E. Abdel-Raheem, and M. Ahmadi, "Joint Optimal Transmission Power and Sensing time for Energy Efficient Spectrum sensing in Cognitive Radio System," IEEE Sensors J., vol. 17, no. 2, pp. 369–376Jan. 2017.

[13]. G. Ozcan, M. C. Gursoy, N. Tran, and J. Tang, "Energy-efficient power allocation in Cognitive Radio Systems with Imperfect Spectrum Sensing," IEEE J. Sel. Areas Commun., vol. 34, no. 12, pp. 3466–3481,Dec. 2016.

[14]. F. Yao, H. Wu, Y. Chen, Y. Liu, and T. Liang, "Cluster-based Collaborative Spectrum Sensing for Energy Harvesting Cognitive Wireless Communication Network," IEEE Access, vol. 5, pp. 9266–9276, May 2017.