VOL. 10, NO. 4, MARCH 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

MAXIMIZING THE LIFETIME OF COGNITIVE SENSOR NETWORK USING SUB FUSION CENTERS

Jenifer Angel J. and Punal M. Arabi
ECE Department, SNS College of Technology Coimbatore, India
E-Mail: jeniferange186@gmail.com

ABSTRACT

A cognitive radio is a transceiver which enables an unlicensed user to adaptively adjust its operating parameters and exploit the spectrum which is unused by licensed users in an opportunistic manner. Cognitive Radio optimizes the utilization of radio resources, by switching channel to the most suitable transport channel based on traffic volume (throughput), radio resources availability, radio conditions and mobility. Spectrum opportunity deals with the usage of an available (free) channel that is a part of the spectrum which is not currently used by primary users. Extending the lifetime of the energy constrained wireless sensor networks is a main challenge in sensor network applications.

In this paper a novel method is proposed to enhance the lifetime of the nodes by introducing sub fusion centers between the sensor nodes and the main fusion center of the cognitive sensor network. Each sensor sends its spectrum sensing result to the sub fusion centers, which combines the local decisions and then send that to the main fusion center to make a final decision. The proposed method is tested with two network models with and without sub fusion centers. The results simulated using NS-2 shows that there is a reduction in consumed energy in the proposed network model. Hence the remaining energy in the proposed model is more which ultimately lead to the maximization of it's life time.

Keywords: cognitive sensor network, sub fusion centers, maximizing lifetime of network, performance analysis.

1. INTRODUCTION

The present day cognitive wireless technology is a well grown one. Cognitive Radio (CR) is a key technology for realizing dynamic Spectrum Access and is an is an opportunistic network [1].Cognitive radio operates by a process known as dynamic spectrum management; i.e., it automatically detects available channels in wireless spectrum and accordingly changes its transmission or reception parameters so more wireless communications may run concurrently in a given spectrum band at a place [2]. Spectrum sensing has an important role in cognitive radio networks which leads to better spectrum utilization. Cognitive radios are of two types depending on transmission and reception parameters. The first one is full cognitive radio in which every possible parameter observable by a wireless node (or network) is considered. The second one is spectrum sensing radio in which only the radio-frequency spectrum is considered. Cognitive radio was initially thought of as a software-defined radio extension (full cognitive radio), most of the research works focus on spectrum sensing cognitive radio. The main problem in spectrum sensing cognitive radio is designing high-quality spectrum sensing devices and algorithm for exchanging spectrum sensing data between nodes. Increasing the number of a cooperative sensing node decreases the probability of false detection in spectrum pooling system [3]. Cooperative sensing is one of the sensing techniques. Cognitive radio wireless sensors suffer highly from hardware constraints and hence cannot sense multiple channels simultaneously; so CR wireless sensors cooperate and share their sensing information with each other to improve the sensing performance and accuracy [4]. Life time Maximization is of prime importance in wireless sensor networks [5]. To maximize the Lifetime, techniques that would reduce the energy consumed by sensor nodes are to be used.

Centralized cooperative sensing is a type of cooperative sensing method. Spectrum sensing techniques provide the particular channel whether the PU's signal is present or not. CR wireless sensors perform the operation to sense whether its spectrum is present or not. Then CR WSN forwards their local decision to the central cooperate, such as a fusion center, collector. The central cooperator fuses the received local decision of the CR wireless sensors and makes a final decision. If CR WSN wants to send data it requests channel information from the central cooperator [6].

CR-WSNs may have a wide range of application domains. CR-WSN can be deployed anywhere in place of WSNs (7). Some examples of prospective areas where CR-WSNs can be deployed are as follows: facility management, machine surveillance and preventive maintenance, precision agriculture, medicine and health, logistics, object tracking, telemetries, intelligent roadside, security, actuation and maintenance of complex systems, monitoring of indoor and outdoor environments.

In this paper, a method with sub fusion centers is proposed to reduce the energy consumed by the CR WSN .This paper is classified into the following sections. Section (II) describes the literature review done for Maximizing the lifetime. Section (III) describes the proposed model. Section (IV) shows simulation results and comparison table. Section (V) describes the module and Section (VI) ends with the conclusion and future work.

ARPN Journal of Engineering and Applied Sciences

2. LITERATURE SURVEY

A. Energy efficient method

To minimize the energy consumed in distributed sensing, the detection performance improves with the number of radios. It considers a combined sleeping and censoring scheme as an energy efficient spectrum sensing technique for cognitive sensor networks [8].

B. Minimize the energy consumption

Energy-efficient spectrum sensing technique is based on on/off modes and finding the best location of DN policies. It considers minimizing energy consumption and improving spectrum sensing performance simultaneously. The problem of sensor selection in order to achieve energy efficiency in spectrum sensing while reducing complexity is formulated [9].

C. Maximize the lifetime of networks

The Analytical model to estimate and evaluate the node and network lifetime in a randomly deployed multi-hop sensor network is presented. This will extend the lifetime of the communication critical nodes, and as a result the overall network's operation life time [10].

A novel approach based on fuzzy logic systems to analyze the lifetime of a wireless sensor network. Here are two basic sensor placement schemes: square-grid and hex-grid. The two fuzzy logic systems of (FLSs)(a singleton type-1 FLS and an interval type-2 FLS) are designed to perform lifetime estimation of the sensor network [11]. Distributed algorithms to compute an optimal routing scheme that maximizes the time at which the first node in the network drains out of energy. The resulting algorithms have low computational complexity and are guaranteed to converge to an optimal routing scheme that maximizes the network lifetime [12].

3. PROPOSED MODEL

In the proposed method the sub fusion centers are introduced in the CR WSN scenario**.** To maximize the minimum remaining energy by reducing the path loss, sub fusion centers are introduced in between the sensor nodes and main fusion center. These sub fusion centers take a main role to minimize the consumed energy by reducing the path loss. The sub fusion center is collecting the data from N numbers of cognitive sensors. After collecting the data it takes the local decision and sends to the main fusion center which will then be given to the server. Here sub fusion centers are used to reduce the consumed energy and path loss. Since there is a detection in energy consumption, the lifetime of the network is increased.

Performance analysis of CR WSN arranged in parallel distributed spectrum sensing with the proposed sub fusion centers is done. The sub fusion center (FC) placed in between main FC and sensor nodes. CR sensor sends the data to the sub fusion center. Sub fusion centers collect all data from sensors then these sub fusion centers take own local decision. After finalizing the local decision, these data are sent to the main fusion center (FC) and then to the server.

A. Sensor network model with sub fusion centers

This section deals with the analysis of the energy consumption of the CR WSN with sub fusion centers. The sub fusion centers act like helpers for main fusion center. Using this sub fusion reduces the energy consumed by reducing the path loss in CR WSN. The actual scenario using sub fusion centers is shown in Figure-1.

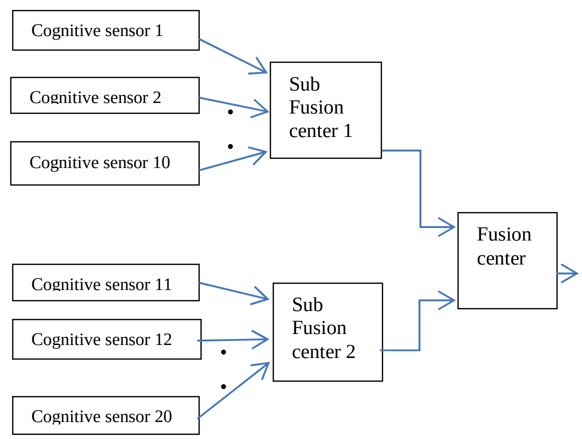

Figure-1. Distributed spectrum sensing network model with sub fusion centers.

The performance analysis of the proposed CR WSN with sub fusion centers is done for 24 sample nodes arranged in a parallel manner. Each node has fixed energy of 100J. The analysis done using network simulator tool NS-2. Then sensors considered here send the data to the sub fusion centers for particular time period. In this analysis we take two sub fusion centers of 24 nodes then sub fusion center collects the data from this 24 sensors node. Then these sub fusion centers fuses the sensors output after this, it takes a local decision from the received data. This local decision is sent to the main FC which will take some time to take a final decision; then sends the decision to the server.

4. SIMULATION RESULTS AND COMPARISON TABLE

The comparison between the two methods of distributed spectrum sensing in CR WSN using with and without sub fusion center is given in the table shown below. The Table-I actually shows how much energy is consumed and how much is remaining in CR WSN with and without sub fusion center.

Table-1. Remaining Energy (J) with and without sub fusion center.

Methods	Remaining Energy (J)	Consumed Energy (J)	Remaining Energy(J) in percentage
Spectrum sensing with sub FC (Proposed Method)	1974.34	425.663	82.264%
Spectrum sensing with main FC (Existing method	1946.83	453.166	81.12%

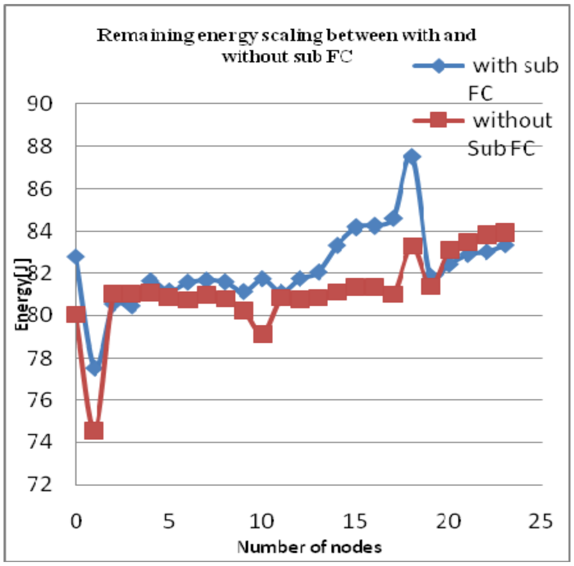

Figure-2. Comparison graph.

Figure-2 is a graphical comparison between the remaining energy with and without sub FC of a CR WSN. Here X-axis shows the number of sensor nodes and Y-axis shows the remaining energy [J].

5. DISCUSSIONS

The sub fusion center is collecting the data from N numbers of cognitive sensors. After collecting the data it takes the local decision and sends to the main fusion center which will then be given to the server. Here sub fusion centers are used to reduce the consumed energy and path loss. Since there is a detection in energy consumption, the lifetime of the network is increased.

Based on the data given by the cognitive sensor, the sub fusion centers take the first level decision which they then send to the main fusion center. The main fusion center based on these received first level decisions, make the final decision and communicate that to the server. Here the introduction of the sub fusion centers reduced the path loss since a group of sensors is connected to one sub fusion center and the rest are connected to the other sub fusion center. Hence an increment in the remaining energy which leads to maximization of life time.

The performance analysis of the proposed CR WSN with sub fusion centers for 24 sample nodes arranged in a parallel manner can be done by comparing the energy consumed and energy remaining in the network with that of a CR WSN with only the main fusion center for the same 24 sample nodes arranged in parallel manner. The energy remaining in the proposed network is 1974.34 **(J)** where as that for the CR WSN with only the main fusion center is 1946.83 **(J)**. The energy consumed by these two networks are 425.663**(J)** and 453.166**(J)** with the remaining energy as 82.264% and 81.12% respectively. Even for 24 nodes there is a considerable amount of saving in the remaining energy is witnessed here.

6. CONCLUSIONS AND FUTURE WORK

The problem of using multiple fusion centers for cooperative spectrum sensing is considered, in which the fusion channels run from sensors to sub fusion centers which are connected to the main fusion center. Two different cognitive sensor network models are examined here. They are: (1) Sensor network with sub fusion centers. (2) Sensor network with only a main fusion center. Their performance on the lines of consumed energy, remaining energy was compared.

The initial simulation done shows that there is a definite possibility of the network life time to be increased by the introduction of sub fusion centers between sensor nodes and the main fusion center. Possible future work could include the performance analysis of different cognitive sensor network models like models with decision nodes, sub nodes acting as helper nodes. The design complexity and cost impact would also be an important aspect of future analysis.

REFERENCES

[1] M. Najimi., A. Ebrahimzadeh., S. M. H. Andargoli. and A. Fallahi. Lifetime Maximization in Cognitive SensorNetworks Based on the Node Selection. IEEE Sensors J., vol. 14, no. 7, July 2014.

[2] S. M. Mishra., A. Sahai. and R. W. Brodersen. Cooperative sensingamong cognitive radios. In Proc. IEEE ICC, Istanbul, Turkey, Jun. 2006,pp. 1658–1663.

[3] Q. Zhao. and B. M. Sadler. A survey of dynamic spectrum access. IEEE Signal Process. Mag., pp. 79–89, May 2007.

[4] I. F. Akyildiz. B. F. Lo. and R. Balakrishnan. Cooperative spectrumsensing in cognitive radio networks: A survey. Elsevier Phys. Commun.,vol. 4, no. 1, pp. 40–62, Mar. 2011.

[5] M. Najimi., A. Ebrahimzadeh., S. M. H. Andargoli. and A. Fallahi. A novel sensing nodes and decision node selection method for energyefficiency of cooperative spectrum

sensing in cognitive sensor networks. IEEE Sensors J., vol. 13, no. 5, pp. 1610–1621, May 2013.

[6] J. Zhu. and S. Papavassiliou.“On the energy-efficient organization andthe lifetime of multi-hop sensor networks. IEEE Commun. Lett., vol. 7,no. 11, pp. 537–539, Nov. 2003.

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

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

[9] M. Najimi., A. Ebrahimzadeh., S. M. H. Andargoli. and A. Fallahi. A novel sensing nodes and decision node selection method for energy efficiency of cooperative spectrum sensing in cognitive sensor networks. IEEE Sensors J., vol. 13, no. 5, pp. 1610–1621, May 2013.

[10] H. Shu., Q. Liang. and J. Gao. Wireless sensor network lifetime analysis using interval type-2 fuzzy logic systems. IEEE Trans. Fuzzy Syst., vol. 16, no. 2, pp. 416–427, Apr. 2008.

[11] J. Zhu. and S. Papavassiliou. On the energy-efficient organization and the lifetime of multi-hop sensor networks. IEEECommun. Lett. vol. 7, no. 11, pp. 537–539, Nov. 2003.

[12] R. Madan. and S. Lall. Distributed algorithms for maximum lifetime routing in wireless sensor networks. IEEE Trans. Wireless Commun. vol. 8, no. 5, pp. 2185–2193, Aug. 2006.