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Review Article

A REVIEW ON A GENETIC ALGORITHM BASED SPECTRUM SHARING STRATEGY USING ENERGY EFFICIENT CLUSTERING FOR COOPERATIVE CR NETWORKS

Durgesh Sahu[1]* and Prabhat Patel[1]

Corresponding Author: **Durgesh Sahu ✉ lucky.durgesh@gmail.com*

Cognitive radio is emerging as a promising technique to improve the utilization of radio frequency spectrum. In this research proposal, consider the problem based on energy constrains in a cognitive radio network. In this research proposal an energy efficient transmission structure is propose. An energy dependent dynamic clustering technique is implemented to save energy disbursed in broadcasting results and swapping information between IUs-PU and IUs-SUs. All the cognitive radios are grouped in few clusters and clusters choose clusters head by genetic algorithm criteria, clustering based cooperative spectrum sensing scheme using Centralized energy based selection scheme. Clusters head collect packets from their respective cluster nodes in a TDMA manner and make decision through certain data fusion scheme. Clusters head decisions are forward to the common fusion centre to decide whether the spectrum is idle or not. This proposed work reduce the power consumption, increase the network throughput, network's life time and reduce the end to end delay of cognitive radio network as compare to traditional clustering based approach.

Keywords: Cognitive radio, Spectrum sharing, Cooperative spectrum sensing, Clustering technique, Energy efficiency, Genetic algorithm

INTRODUCTION

Wireless communication systems have been widely and successfully deployed all over the world. Day-by-day, upper layer protocols demand high speed wireless access with very low delay requirements for applications in data, voice, video and other high bandwidth urge multimedia applications. However, the radio spectrum band available to serve the wide variety of all these emerging applications is strictly limited. The regulatory bodies licensed the radio spectrum, implementing strict limitations on operators and manufacturers protecting the radio resource and licensed users. This commandants-control nature of regulations limits the access of radio resource which is a more important problem than

[1] Department of Electronics & Communication Engineering, Jabalpur Engineering College, Jabalpur-482011(M.P), India.

the physical scarcity of spectrum. Further it is discovered that, some frequency bands are largely underutilized most of the time or partially occupied, even in revenue rich urban areas. The Cognitive radio was proposed as a mechanism to efficiently utilize such free bands (spectrum holes) by exploiting its availability by Cognitive Users (CUs).

In order to complete these cognitive tasks in cognitive radio network, the CU must perform additional tasks than a normal wireless user. The detection of spectrum holes (spectrum sensing) with sufficient reliability is one such major task to perform by CUs.
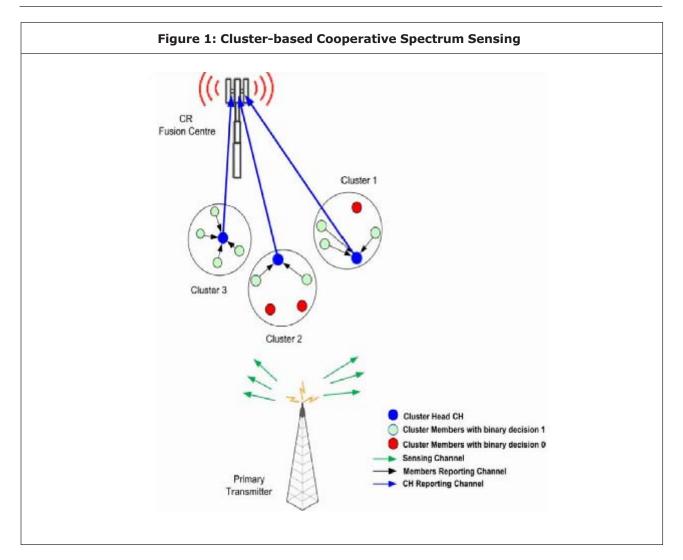
Cognitive Radio

Cognitive radios are wireless radios that opportunistically share the spectrum while avoiding any imposed harmful interference to the primary licensed users. Depending on the way that cognitive radios tackle the problem of interference to the primary user, three categories of cognitive radios are defined. These categories are underlay, overlay and spectrum-sensing (or interweave) cognitive radios. In underlay and overlay systems, the cognitive radios are transmitting at the same time with primary users within the same band, while keeping their interference below a certain level. The difference between the underlay and overlay cognitive radios is that in the underlay systems, cognitive radios need to access the channel side information and in the overlay systems they need to have knowledge about the codebook side information and messages that the primary users send .

Interweave cognitive radios; on the other hand, employ spectrum sensing to detect the empty portions of the radio spectrum (also known as

spectrum holes) at a certain time and geographical location. Upon detection of such a spectrum hole, cognitive radios dynamically share this hole by adapting their transmission power and modulation according to the available resources and the surrounding environment. However, as soon as a primary user appears in the corresponding band, the cognitive radios have to vacate the band. This way, transmission is limited to the bands that are deemed to be empty in order to avoid interference to the primary users. In order to accomplish these tasks, a harmonious cooperation among cognitive users is required which is coordinated through a dedicated control channel. In this research work, our focus is on this category of cognitive radios and whenever we talk about a cognitive radio, we means an interweave cognitive radio.

PROBLEM STATEMENT

Cooperative spectrum sensing improves the detection performance of the cognitive radio network. However, such a gain in performance comes with a resulting higher network energy consumption which is a critical factor in a low-power radio system.

Although the network energy consumption is an important factor, considering the fact that cognitive radios are in general low-power sensors, the individual energy consumption of each cognitive radio is a much more critical issue, because the maximum energy consumption of a low-power radio is limited by its battery. As a result, designing energy-efficient spectrum sensing algorithms in order to limit the maximum energy consumption of a cognitive radio in a cooperative sensing framework is the focus of this work.

Figure 1: Cluster-based Cooperative Spectrum Sensing

PROPOSE SYSTEM MODEL

A cognitive radio network with one Primary User (PU), N Secondary Users (SUs) is considered. Out of N SUs, M Intermediate Users (IUs), acting as local sensing device, are assumed to be organised into clusters, where each cluster has a Cluster Head (CH) that makes a cluster decision based on the local decisions received from its cluster members and report the result to the cognitive base station that acts as a Fusion Centre (FC).

The system model has been considered with the following assumptions:

a. We assume that a CRN topology is stable and consists of one fusion centre FC, one primary transmitter and M of Intermediate users IUs chosen from N Secondary users SUs.

b. The FC has the location information of all the CRs, possibly determined using Global Positioning System (GPS).

c. The instantaneous channel state information of the reporting channel is available at the CRs.

d. The channel between any two IUs in the same cluster is perfect since they are close to each other.

As the primary user's signal type is not initially known, therefore, an energy detector is employed to conduct the local sensing, which is suitable for any signal type. In this energy detection algorithm, it is assumed that the transmitted power of the primary system is known. Therefore, this power is detected first, and then compared with a predefined threshold λ. Based on this comparison, it is decided whether the spectrum band can be used for secondary transmission or not.
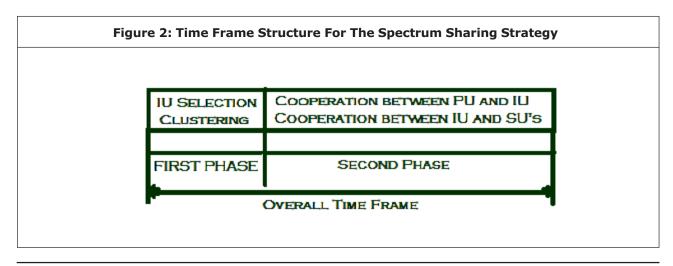
The system structure of a cognitive radio network, according to the clustering approach, is illustrated in Figure 1. First, all IUs are grouped into clusters using proposed intelligent genetic algorithm and energy distribution based protocol. This protocol provides an efficient clustering configuration algorithm, in which the Cluster Heads (CHs) are selected by the proposed scheme in a centralised way, which minimizes the data transmission energy between a CH and other members in a cluster, according to the best reporting channel gain and the energy level of the IUs.

This energy efficient spectrum sensing protocol maintains such clustering hierarchy. In our protocol, the clusters are re-established in each round. New cluster heads are elected in each round and as a result the load is well distributed and balanced among the nodes of the network. Moreover each node transmits to the closest cluster head so as to split the communication cost to the sink (which is tens of times greater than the processing and operation cost).

Proposed Cluster Based Approach

In this paper, we propose cluster-based cooperative spectrum sensing algorithm using our new energy distribution check mechanism based protocol for cognitive radio networks. We demonstrate that our clustering approach extends the lifetime of cognitive networks and try to maintain a balance energy consumption of CR users. Furthermore, we present a reporting strategy that reduces the average number of reporting decisions, by allowing only the CR with detection information to send its binary decision (0 or 1) to CH.

As shown in Figure 2, the cooperation between SUs and PU takes place in a two-phase cooperation scheme in each timeslot 5G. The first phase selected cluster head IU and clustering within the network, while the second phase cooperation is between the PU and with the

Figure 2: Time Frame Structure For The Spectrum Sharing Strategy

selected IU and cooperation is between the cluster head and other SUs in the cluster. The partner IU selection scheme is first performed, and then the cluster head IU cooperates with the PU in a TDMA manner that the PU transmits its package to the cooperating IU and the IU relays PU's last package to the BS simultaneously. After the cooperation between PU and IU, the IU finds the cooperative SUs who form a cluster from the surrounding starving SUs.

General Review of Previous Methods

1. Yujie Tang, Yongkang Liu, Jon W. Mark and Xuemin (Sherman) Shen, (2013).

In this paper, a spectrum sharing strategy in Cooperative Cognitive Radio Network (CCRN) is investigated. Specifically, multi-phase cooperation architecture is proposed including cooperation partner selection and spectrum sharing among Secondary Users (SUs). The cooperation partners who are selected from SUs forward the data of Primary Users (PUs), and then acquire the spectrum access opportunities for their own transmissions as a reward. To improve the utility for the PU-SU cooperation pairs, the partner selection is modelled as an optimally weighted bipartite matching problem to maximize the total utility where energy efficiency is also considered. The partner SU further improves spectrum utilization by sharing the acquired spectrum with the surrounding SUs via cooperative network coding.

2. Sepideh Zarrin (2011)

In this paper, author maximizes the throughput of a Cognitive Radio (CR) network with respect to the frame length when quickest sensing is used. The amount of interference to the primary network, measured by the probability of collision with PUs, is constrained. The corresponding problem when CRs use block sensing is also solved, assuming that collision with PUs causes a drop in throughput for the CR– this important assumption was missing in prior work. Author then compare the maximum achievable throughput with block and quickest sensing schemes and show that for the same protection level to the primary network, the quickest sensing approach results in significantly higher average throughput.

3. Shaojie Zhang (July 2014).

This paper investigates the sensing-throughput trade off problem in cognitive radio networks from across-layer perspective, jointly considering the impact of imperfect spectrum sensing and access contention. Furthermore, the optimized solution to this trade off is formulated via taking the interference probability, rather than the detection probability, as the optimization constraint. Compared with the results obtained only from the physical layer, the proposed solutions can improve the secondary throughput significantly.

4. Kae Won Choi (2010).

A CR system exploits spectrum bands that primary users (PUs) are licensed to use. The CR performs channel sensing to find spectrum opportunities. Conventional periodic sensing schemes require a long sensing time to detect a weak signal from the PU with fast channel- usage variation. Since the CR network should be quiet during a sensing period, a long sensing time results in low spectrum utilization. To improve spectrum utilization, author propose a novel sensing scheme that adaptively decides whether to sense the channel or to transmit the user data based on previous sensing results. The simulation

results show that the proposed scheme significantly outperforms the conventional scheme.

5. Yulong Zou (ACCEPTED TO APPEAR).

In this paper, author investigate a *selective relay spectrum sensing and best relay data transmission* (SRSS-BRDT) scheme for multiple-relay cognitive radio networks. Specifically, in the spectrum sensing phase, only selected cognitive relays are utilized to transmit forward their initial detection results (without a dedicated sensing relay channel) to a cognitive source for fusion, where the dedicated sensing channel refers to the channel transmitting initial spectrum sensing results from cognitive relays to the cognitive source. In the data transmission phase, only the best relay is selected to assist the cognitive source for its data transmissions. By jointly considering the two phases, author derives a closed-form expression of the outage probability for the SRSS-BRDT scheme over Rayleigh fading channels. Authors show that the SRSS-BRDT scheme outperforms the traditional cognitive transmission scheme (with a limited dedicated sensing channel) in terms of the outage probability performance.

6. Xin Kang (2009).

In this paper, a new spectrum-sharing model called sensing based spectrum sharing is proposed for cognitive radio networks. This model consists of two phases: In the first phase, the Secondary User (SU) listens to the spectrum allocated to the Primary User (PU) to detect the state of the PU; in the second phase, the SU adapts its transit power based on the sensing results. If the PU is inactive, the SU allocates the transmit power based on its own benefit. However, if the PU is active, the interference power

constraint is imposed to protect the PU. Under this new model, the evaluation of the ergodic capacity of the SU is formulated as an optimization problem over the transmit power and the sensing time. Due to the complexity of this problem, two simplified versions, which are referred to as the perfect sensing case and the imperfect sensing case, are studied in this paper.

7. Wenshan Yin (2012).

Periodic spectrum sensing over the entire Primary User (PU) band always interrupts the Secondary User (SU) data transmission in the sensing interval, which may degrade the quality of service of the SU. To alleviate this problem, author divide the PU band into two sub bands, one for opportunistic SU data transmission, and the other for continuous spectrum sensing. Based on the PU band division, author proposes a delay oriented continuous spectrum sensing (DO-CSS) scheme for delay sensitive SU services. In the DO-CSS scheme, the average SU transmission delay is reduced by selecting the proper bandwidth for spectrum sensing within each frame. Since different SUs may have different requirements on their quality of services, author further propose a throughput oriented continuous spectrum sensing (TO-CSS) scheme. In the TO-CSS scheme, the achievable average SU throughput is maximized by choosing the optimal sensing bandwidth within multiple adjacent frames.

CONCLUSION

In above literatures review varies type of spectrum sharing and spectrum sensing methods are investigated. In this research proposal we formulate the problem based on bandwidth allocation in total frame. Total frame time is divided into two phases. In first phase the intermediate user selection and cluster formation

is done on the same time slot by using centralised energy and distance criteria. In second phase there is a spectrum sharing between IU-PUs and IUs and SUs by using genetic algorithm and energy efficient cluster based TDMA protocol. The efficiently utilization of energy with in a cluster increases the spectrum sharing between IUs and PUs which increased the network life time. As network life time will increase which will also increase the network throughput and reduces end to end delay.

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