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Optimization of Cooperative Spectrum Sensing and Network Lifetime Maximization of Cognitive Radio Sensor Networks by MODLEACH

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ABSTRACT: Dynamic spectrum access techniques are proposed to solve the limited available spectrum and inefficient spectrum utilization problems. The key technology for dynamic spectrum access techniques is cognitive radio networks. Cognitive radio sensor network (CRSN) is a recently emerging paradigm that aims to utilize the unique features provided by CR concept to incorporate additional capabilities to Wireless Sensor Network (WSN). The realization of CRSN depends on addressing many difficult challenges, posed by the unique characteristics of both cognitive radio and sensor networks, and further amplified by their union. Nodes in the Networks (CRSNs) are limited battery powered. Therefore energy efficient routing has become an important optimization criterion in CRSN. The modeling of the spectrum occupancy is a prerequisite for cognitive radio analysis. Optimization on the basis of modified leach algorithm was proposed other than the existing greedy algorithm. Accordingly network lifetime maximization can be obtained through the proposed system. This paper attempts to provide an energywise routing algorithm. The proposed algorithm checks out the transmission energy between the nodes regarding the distance between nodes and compared the performance of both the existing and MODLEACH. The proposed algorithm shows more efficiency in energywise utilization and increased network lifetime with total transmission energy.

KEYWORDS: Energy efficient algorithm;LEACH,MODLEACH;clustering;optimization;CRSN;cooperative communication; Greedy; network lifetime.

I. INTRODUCTION

In the present era of communication, the radio spectrum is used based on fixed communication policy, where the available spectrum is either allocated to license holders, such as TV bands or it is allocated to unlicensed holders for use with on agreed-upon etiquette, such as the ISM band. Currently because of the increase in spectrum demand, this static spectrum assignment policy has been faced with spectrum scarcity at particular spectrum band. For instance, US Federal Communication Commission made a measurement based on spectrum usage, which indicates that the need of continuous and fast technological evolution creates the demand of new dedicated spectrum band and one of new important observation revealed through the analysis of FCC is the under utilization of most of the licensed spectrum bands allocated to the current inorders. Subscribers in both temporal and spatial domains. The usable portion of the radio spectrum is limited. Inorder to meet the spectrum scarcity problems FCC proposed the use of unlicensed devices in licensed bands, therefore dynamic spectrum access techniques proposed to overcome the issue of spectrum scarcity. In particular, cognitive radio(CR), a key enabling technology has been viewed as a promising approach to tackle the concern. A CR is an intelligent wireless communication system which is aware about its surroundings and adapts its internal parameters inorder to achieve a reliable communication and efficient spectrum utilization. Through CR technology, vacant portions of the radio spectrum that is originally assigned to licensed users called Primary Users

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(PUs) and can be opportunistically utilized by unlicensed users called Secondary Users (SUs) or Cognitive users, the underutilized band of frequencies are termed as `white spaces' or spectrum holes' and such opportunistic spectrum sharing in a non interfering manner is re_ered as dynamic spectrum access (DSA).

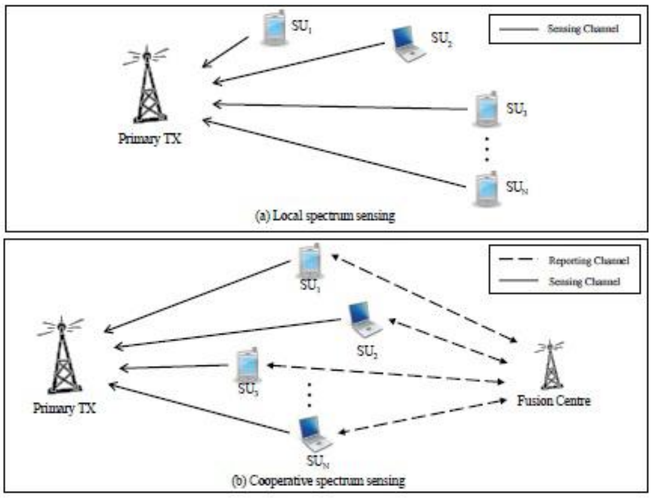

Fig.a: Non cooperative sensing vs Cooperative spectrum sensing

Nowadays there is many research and investigation by many industrial organizations and natural administrations in the closely related topics of dynamic spectrum management, flexible spectrum use, dynamic channel assignment and opportunistic spectrum management.Through Cognitive Radio technology, the radio spectrum can be utilized by both licensed and unlicensed spectrum holders. Developing analytical model that consider the occuppancy of the radio spectrum by two type of users such as licensed users and unlicensed users, therefore, is listed as one of the major research challenges in CR. So it is very essential to understand the theory behind CR algorithm and to evaluate the performance in the basis of different algorithms. CR is designed to be aware of and sensitive the changes in its sur-
roundings which makes spectrum sensing an important requirement for the realization of CRNs. Through spectrum sensing secondary users monitor the primary networks activity to opportunistically use the spectrum and to vacate the spectrum in case where a Primary User (PU) appears. Many challenges are associated with spectrum sensing task. Among different sensing methods, non-Cooperative spectrum sensing, each SU individually performed the spectrum sensing task. In other words, there is no collaboration between different SUs. In such cases, it is relevant to obtain the optimal sensing frequency in order to achieve predetermined goal, such as maximization of secondary networks throughput. Cooperative spectrum sensing method is an another group of sensing methods. Through this, SUs perform collaborate sensing task. In Fig(a) depicts the comparison of non-cooperative spectrum sensing and local spectrum sensing scheme. As shown in figure, in non-cooperative sensing each sensor must have the ability to sense the whole channel and elemence on optimal scheme to maximize its benefits, such as its throughput. Besides, in the co-operative sensing scheme, each SU senses the spectrum and reports its local sensing result to a data fusion center FC), which gathers all local sensing results and makes final decision on the presence or absence of the PU. At last final decision is forwarded to all SUs. Design challenges are included in co-operative spectrum sensing but are not limited to finding the number of required co-operative users and the most qualified SUs in terms of energy level and sensing accuracy. SUs in terms of energy level and sensing accuracy.

`All technologies that is in its development stage , give a lot of demands. By the same manner, cognitive radio sensor networks do so . Spectrum sensing , management , mobility , sharing of spectrum by minute sized sensors with power constraint is not a simple thing. Therefore this is the major concern for all scientists and researchers. Inorder to optimize network node's lifetime, we need to focus on such algorithms, protocols and physical circuitries that can make maximum out of limited power source. In any network especially multi hop wireless networks, for efficient performance, its protocols must be very efficient. Numerous protocols are developed that address power problem
in sensor networks. Energy efficient routing algorithms can be categorized by three main ways i.e ;direct transmission algorithms, hop to hop transmission algorithms and cluster based algorithms. One of the main problem that also affects

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this network is to handle bulk of information that sensed and transmitted every node by node over the network. A CRSN consists of thousands of node. Data aggregation and fusion algorithms are work for such networks.
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` In an efficient cognitive radio sensor network, we need efficient routing protocol that has low routing overhead and need to well organized data aggregation mechanisms to increase throughput of network and to save limited power of sensor node. Next sections, we discuss about the work done on cluster based routing of cognitive sensor networks along with areas which need modifications to enhance efficiency. Then, some modifications are made in one of most prominent routing protocol. Finally, comparisons between existing and modified model are made and discussed briefly.

II. RELATED WORK

Earlier in 1993, Joseph Mitola III proposed a novel idea of dynamic spectrum sharing of the spectrum bands exclusively allocated to the licensed users using novel devices called Cognitive Radios [8]. Mitola envisioned CR as a combination of existing wireless technology and artificial intelligence. The need for CRs is primarily motivated by the complexity of radio systems itself. Conventional radio design is targeted for single purpose and single environment.
The key enabling technology for cognitive wireless networks is the software defined radio (SDR) which first emerged in 1990 [9]. SDR aims to bring radio electronics into the digital age, thus adding new degrees of freedom in designing wireless networks by enabling radios to adapt to the requirements at hand [10]. These radios perform signal processing in software, thus enabling the devices that can be reconfigured via software after deployment. SDRs find their applications in industry, academia, government and military organizations, communication research, data acquisition and many more. However, the radios built on SDR technology are expensive, since they support multiple interface technologies e.g. GSM, CDMA with a single modem by reconfiguring it in software. Thus, a CR is an SDR, that is fully programmable to interact with its operating environment and dynamically adapts its parameters i.e. carrier frequency, modulation technique, transmit power, channel access method and networking protocols to deliver the best application performance. In [1] Since replacing the battery is the problem of maximizing the network lifetime by optimally scheduling each sensor active time in a sensor-aided CR network. We divide the sensors into a number of non-disjoint subsets based on their individual channel conditions not feasible in many applications, energy efficiency emerges as a main issue. As presented in [15], the power consumed by an active sensor is 34 mW, but when the sensor sleeps, it is approximately 0.4 mW. Therefore, the network lifetime can be extended an optimal scheduling of each sensor active time can effectively. For the practical purpose of using the energy-constrained sensor network for spectrum sensing [16], it is critical to optimally schedule the battery-powered sensors to maximize the network lifetime while ensuring that the necessary detection and falsealarm thresholds must be satisfied. The significance of sensing period optimization on the secondary net- work power consumption and throughput can be elaborated.

III.PROPOSED ALGORITHM

To achieve better performance than existing work, reduce the number of full transmission by proposing that each cluster-head will transmit its data in its respective cluster and then all the cluster members will compute the difference between its own sensed data and received data. After this we use the hierarchy technique, in which divide the cluster-heads into three levels. First of all find the cluster-head nearest to the base station called the first level node. Then find the next two cluster heads nearer to the base station called the second level nodes. Now the farthest two cluster-heads transmit their data to the second level nodes which aggregate this data and then they transmit aggregated data to the first level node. At last this level cluster-head aggregates the whole data and transmits to the base station. Since energy consumption is less in computation as compared to transmission, proposed system will save energy by reducing the number of full transmissions without affecting the integrity of data collection at base station. The algorithm for the process have been followed:

- STEP 1: Nodes are randomly deployed in square field.
- STEP 2: Co-ordinates of Base Station are defined.
- STEP 3: Initial energy of each node is defined.
- STEP 4: Compute the threshold value.
- STEP 5: A random number between 0 and 1 is given to each node.
- STEP 6: Compare the value of each node with the threshold value.

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- STEP7: A node will declare itself as cluster-head if its value is less than threshold value.
- STEP 8: Count the number of cluster heads. If number is less than 5 then move to step 6 other wise move to next step.
- STEP 9: Calculate the distance of each node from the cluster heads.
- STEP 10: Nodes will join their nearby cluster-head and declare themselves as cluster member.
- STEP 11: After the formation of clusters, each cluster head will transmit its data to its cluster members.
- STEP 12: Cluster members compute the difference between their own sensed data and received data.
- STEP 13: Cluster member nodes will transmit difference data to their respective cluster-head. It is the main difference between LEACH and proposed technique as there is transmission of completely sensed data but in this only difference data is being transmitted.
- STEP 14: After that we divide our cluster-heads into three levels. First and the cluster-head nearest to the Base station and called as first level node.
- STEP 15: Then find the next two cluster-heads nearer to the base station and called them as second level node.
- STEP 16: Now the farthest cluster-heads called third level cluster-heads will transmit their data to the second level cluster heads, which, then aggregate the received data.
- STEP 17: Second level cluster-heads will transmit the aggregated data to the first level cluster-head, which then aggregate the received data.
- STEP 18: Cluster-head at first level will transmit the aggregated data to the base station.
- STEP 19:As the first round is completed it will check for alive nodes. If there is alive node then it moves to the next round following from step 4.
- STEP 20:If there is no alive node it shows that communication will not be possible and it becomes the end of network.
- STEP 21:Find out the probability of detection and false alarm of the cognitive sensor network by the essence of spectrum sensing is a binary hypothesis-testing problem:

  $H0$: primary user is absent;$H1$: primary user is in operation

`In Spectrum Sensing we assumed that each sensor performs local spectrum sensing independently. Let H1 be the state that the channel is busy, and channel is idle which is denoted by H0 for the channel is idle. By using an energy detector, by integrating the received signal in bandwidth W over the sensing period ts, the sensor si will compare the collected energy Ei with a predefined threshold εi to decide whether the channel is occupied by PUs.

IV. SIMULATION RESULTS

All simulation were done on MATLAB for cooperative spectrum sensing over non-fading channel AWGN. Compare greedy degradation algorithm with Modified LEACH algorithm using the measured parameters(probability of detection, false alarm probability and network life time) and outputs are shown using graphs. In cognitive radio sensor network one of the energy-efficient techniques is the clustering algorithm. A cluster-based routing protocol can emphasize message exchanges of path search update processes and overhead of storing routing table or other information that could be expensive to update. Member nodes and cluster-head are the two types of CRSN nodes based on the typical clustering algorithms. All the most CRSN is created where the sensors are deployed randomly, which is shown in Fig.1.In this network sensor nodes deployment is done by using modified version of low energy adaptation clustering algorithm called MODLEACH. Sensors are deployed randomly inorder to improve the network life time by the proper optimization of parameters. Sensors are divided into different clusters based on energy and using distance vectors. That is sensors which are more near to the base station are mentioned as cluster heads and members of each cluster is also classified on the basis of distance. Then calculated the detection probability and false alarm probability of spectrum sensing in the cooperative environment., which is shown in Fig.2.

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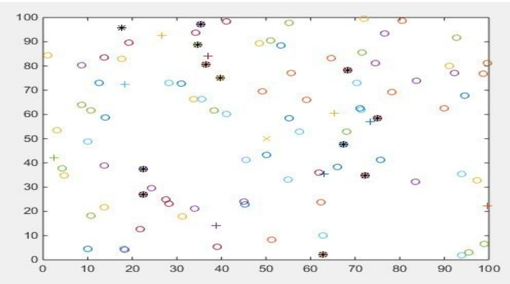

Fig.1. CRSN creation using MODLEACH

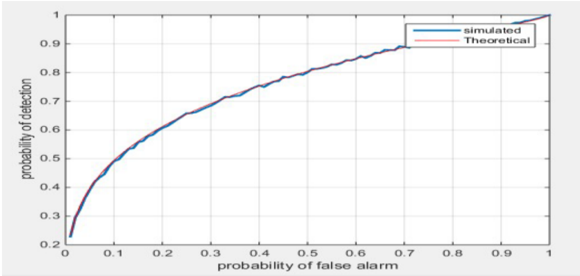

Fig.2: Probability of detection Vs false alarm of Cooperative spectrum sensing

In this work, assume that a cluster at maximum may spread into an area of 10X10m2 in a field of 100X100m2. Energy that is enough to transmit at far ends of a field of 100X100m2 must be lowered 10 times for intra-cluster transmission. When a node act as a Cluster head, routing protocol informs it to use high power amplification and in next round, when that node becomes a cluster member, routing protocol switches it to low level power amplification. Moreover, soft and hard threshold schemes are also implemented in MODLEACH that gives better results. Performance can be evaluated on the basis of two parameters that are network life time and the probability of false alarm against the detection probability. Fig.3 shows the probability of false alarm against the detection probability graph using MODLEACH and and also Fig.4 shows the net work life time of the cognitive sensor network regarding the number of nodes in the network. Simulation is carried out on the behalf of the performance of cooperative spectrum sensing over AWGN channel. This code is to plot receiver operating characteristic curve for simple energy detection, when the primary signal is real Gaussian signal and noise is additive white real Gaussian, the threshold is available analytically.

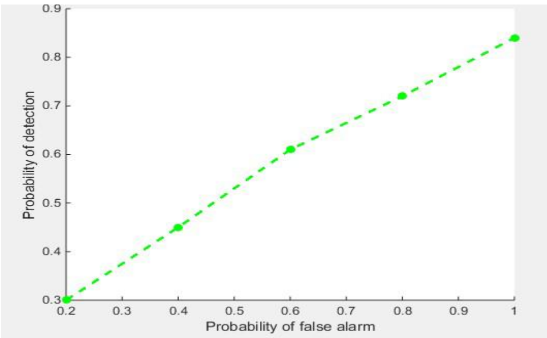

Fig 3: Probability of false alarm vs probability of detection of CRSN by MODLEACH

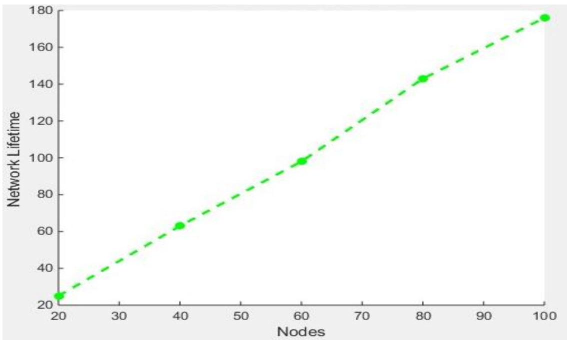

Fig 4: Network life time of nodes under CRSN by MODLEACH

Here, the work is mainly focused on the performance comparison of CRSN using greedy degradation and MODLEACH algorithm .Fig.5 shows the performance comparison with the help of parameters probability of detection and probability of false alarm.Fig.6 depicts the network life time of CRSN with respect to the proper deployment of the sensors in the network using the greedy and MODLEACH algorithm. From the comparisons of both techniques, it is very clear that proposed system performance is better than the existing greedy algorithm. It can be seen from Figure 6 that the nodes in MODLEACH remain to have longer living time than the existing greedy degradation. The time span between the time of the first dead node and that of the last dead node is a reflection of the energy balance among nodes. The shorter the time span is, the better the performance of energy balance among nodes is , thus the more efficient the use of the energy is. Also, it can be seen from Figure that MODLEACH cannot only prolong the network lifetime but also remain the most performance of energy consumption among all nodes and also the network lifetime longer than other protocols due to its cognitive function.

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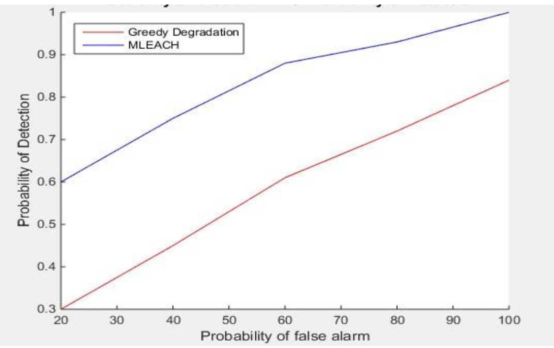

Fig.5:Comparison of probability of falsealarm and detection using greedy and MODLEACH

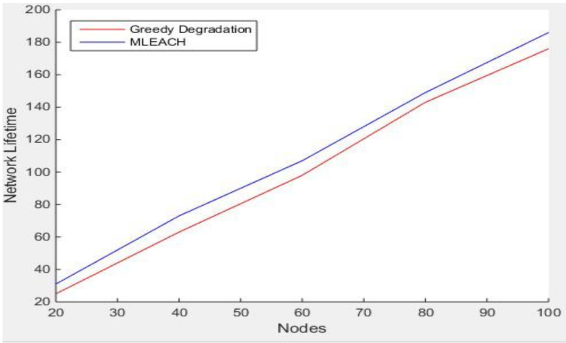

Fig.6: Comparison of network life time under CRSN using greedy and MODLEACH

V. Conclusion and Future Work

The simulation results showed that the proposed algorithm performs better than the existing algorithm. MODLEACH served as a base model for our analysis through this A method of numerically obtaining the optimal detection threshold has been presented. In addition Performance of cooperative spectrum sensing over non-fading channel called AWGN channel was presented. Also studied about the greedy degradation algorithm under the cognitive radio plat-form. From simulations, observed performance over AWGN using MODLEACH better than the existing greedy. Finally compared the result of both existing work and proposed system. Optimized the network parameters by using modified leach protocol and obtained the network life time as maximum than the existing work. The significance of sensing period optimization on the secondary net- work power consumption and throughput can be elaborated. Also discussed the current drawback in the most existing methods where the sensing period is obtained based on the primary network's properties only. This drawback is highlighted by knowing that there exist numerous cognitive radio applications with various sets of design requirements. The proposed algorithm provides energy efficient path for data transmission and maximizes the lifetime of entire network. As the performance of the proposed algorithm is analyzed between two metrics in future with some modifications in design considerations the performance of the proposed algorithm can be compared with other energy efficient algorithm.

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