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A Survey on Distributed Cooperative Spectrum Sensing for Cognitive Radio Network

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ABSTRACT: The Cognitive radio network (CRN) is used to increase the spectrum utilization. The number of applications emergence which demands a bandwidth. This problem is solved using cognitive radio network in which secondary users use the spectrum of primary user opportunistically. This needs sensing of spectrum available from primary user. In the conventional spectrum sensing cooperative spectrum sensing is used to improve the secondary users detection accuracy. A set of secondary user cooperate by sharing their detected data with each other and collectively decide the presence or absence of primary user. In a centralized cognitive radio network, on fusion center the decision is made by collecting the sensing data from all the secondary users in the network. When secondary user senses the spectrum, it is possible that it does not identify the primary user because of deep shadow and this in turns increases the risk interference to primary user also gives the false detection. Distributed cooperative spectrum sensing is preferred to a centralized technique because distributed technique is scalable, fault tolerant and efficient. This paper reviews the various techniques used for spectrum sensing. The performance of spectrum sensing is evaluated in terms of probability of false alarm and probability of missed detection.

KEYWORDS: Cognitive Radio Network, Distributed Cooperative Spectrum Sensing, Centralized Spectrum Sensing.

I. INTRODUCTION

The radio range that is the radio spectrum is bit of the electromagnetic spectrum from 3Hz to 3000GHz. Electromagnetic waves in this frequency range called radio waves, for the most part use as a piece of current advancement particularly in media transmission. The issue of radio frequency spectrum deficiency is started from the static allocation of the bands. The static assignment method leaves a lot of frequency bands underutilized. Dynamic spectrum access presents a adaptive approach for spectrum use that improve more adaptability by permitting secondary users to use the licenses bands on an opportunistic spectrum basis[1].In dynamic spectrum access the spectrum sensing is an important step it is possible that a profound shadow and this thusly expands the danger of impedance to the primary user. The cooperative spectrum sensing has been proposed to improve the secondary users detection accuracy. in this approach, a set of secondary users cooperate by sharing their detected data with each other and collectively decides on the presence or absence of the primary user. In a centralized cognitive radio network, on fusion center take the decision is made by that aggregates the sensing data from all of the SUs in the network. In contrast, in a decentralized network (e.g. a cognitive radio ad hoc network or CRAHN), the nodes must perform a distributed cooperation. Distributed cooperative spectrum sensing (DCSS) is preferred to a centralized technique because a distributed technique is scalable, fault-tolerant and efficient[1]. There are different types of spectrum sensing techniques which are energy detection, cyclostationary detection, matched filter detection, feature detection and wevlet detection.

II. LITERATURE SURVEY

The optimization problem which is described in paper maintains a predefined threshold detection probability and increase throughput of secondary user. Two sensing modes are described: slotted time sensing mode and continues time

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sensing mode. The performance of spectrum sensing is measured by two parameters that is detection probability and false alarm probability. To improve the accuracy of th spectrum sensing in fading environment cooperative spectrum sensing technique is used. To increase the secondary users throughput subset of the channels is used. Subset selection is depends on the channel available probabilities. Optimal subset selection is major challenge to the method [2].

A cooperative spectrum sensing and accessing scheme for all the secondary users is proposed. The secondary users cooperatively sense the licensed channels of the primary users in the sensing slot. If a channel is determined to be idle, the secondary users which have sensed that channel will have a channel to transmit packets in the data transmission slot. After this multichannel spectrum sensing problem as a coalition formation game is formulated, where a coalition corresponds to the secondary users that have chosen to sense and access a particular channel. The utility function of each coalition takes into account both the sensing accuracy and energy efficiency. Distributed algorithm is proposed to find the optimal portion that maximize that aggregates ability of the coalitions in the system is proposed. Simulation result show that the proposed algorithm gives the self organization of the secondary users that achieves a higher aggregate utility after each iteration [3].

The proposed adaptive threshold method is an alternative approach for estimation of the threshold as a function of first and second order statistics of recorded signals. To improve frequency underutilization of wireless spectrum in cognitive radio systems opportunistic spectrum access feature is used. Energy detection technique is used by stetting a proper threshold by detecting the existence of the signal in the spectrum. The result shows that adaptive threshold has low false alarm and missed detection rates. The development of threshold selection method is based on adaptive threshold which is dependent on parameters of minimum number of parameters these parameters are standard deviation coefficient and occupancy span ratio [4].
For the adaptive threshold method, instead of two dimensional image of *I(u,v)* the wireless signal can be presented with *Y(u)* under the boundary of *W(N)*.formulas can be modified and rewritten for the adaptive threshold for spectrum detection as

$$\lambda_u = \mu w(w) + k\sigma w(u) \quad (1)$$

Where,

$$\mu w(u) = \frac{1}{u}\sum_{p=1}^{u} Y(p) \quad (2)$$

$$\sigma w(u) = \sqrt{\frac{1}{u}\sum (Y(p) - \mu w(u))} \quad (3)$$

The computationally optimal version of adaptive threshold can be obtained by calculating the mean and variance in once by

$$\lambda_n = \mu Y + k\sigma Y \quad (4)$$

Where,

$$\mu Y = \frac{1}{(N)^2}\sum_{p=1}^{1} Y(p) \quad (5)$$

And $$\sigma Y = \sqrt{\frac{1}{(N)^2}\sum_{p=1}^{N} (Y(p) - \mu Y)^2} \quad (6)$$

There are mainly two types of spectrum sensing that is distributed spectrum sensing technique and centralized spectrum sensing technique. To analyze the spectrum detection energy detection algorithm is used with Rayleigh fading channel.

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The performance parameters for both the techniques are detection probability and false alarm probability these are formulated as follows [5].

$$P_d = P_{d,ray} * \{1-[Pn * P_{d,ray} + (1-pn)*(1-P_{d,ray})]^2\} \quad (7)$$

$$P_f = P_{f,ray} * \{1-[Pn * P_{f,ray} + (1-Pn)*(1-P_{f,ray})]^2\} \quad (8)$$

In the result analysis and comparison is shown with the centralized and distributed spectrum sensing systems. It shows that the distributed spectrum sensing system is superior than the centralized system.

Cognitive radios are capable of sensing its environment and adapting its internal states by making corresponding changes in certain operating parameters. These cognitive radio technologies are used in mobile and ad hoc networks (MANETs). In cooperative spectrum sensing, a group of secondary users perform sensing by cooperatively exchanging locally included information. There are some malicious secondary nodes which gives wrong information to the neighbor and take advantage of cooperative spectrum sensing and shoot spectrum sensing data falsification attack and results wrong spectrum sensing result. Simulation result measured in two parameters probability of false alarm(PFA) and probability of missed detection(PMD). The relationship between PD and PMD is given by[6]

PMD=1-PD [9]

The paper gives the intuition to the study of energy detection technique as it presents to detecting signals in a band for opportunistic access. Performance of energy detector in detecting unused spectrum is evaluated. In implementing an energy detector, the received signal X(t) is filtered by a band pass filter (BPF), followed by a square law device. The band pass filter serves to reduce the noise bandwidth. The output of the integrator is the energy of the input to the squaring device over the time internal T. Again the output signal Y from the integrator is compared with threshold λ_E, to decide whether a primary user is present or not [7].

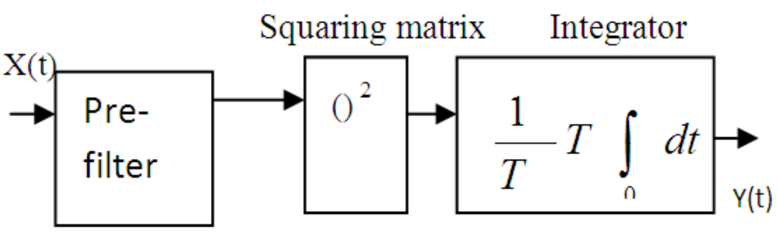

Fig.1:Block diagram for energy detection algorithm[7]

Fig 1 shows the block diagram for energy detection algorithm. Analytically, determining the sample signal(t) is reduced to an identification problem, formalized as an hypothesis test; H0 and H1.
Ho implies an absence of the signal, whereas H1 denotes presence of the signal. This is represented by:

H0: y(n) = w(n))
H1: y(n) = s(n)+w(n) (9)
Where,
X(t) is the sample to be analyzed at each instant t,
n(t) is additive noise,
s(t) is the transmitted signal to be detected.
The performance of energy detector is specified by the 3 metrics. These are Probability of detection, Probability of false alarm and probability of missed detection [7].

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The detection approach is robust to random noise and noise has only a peak of spectral correlation function at the zero cyclic frequency and the different modulated signals have different unique cyclic frequencies. Energy detection method is a non coherent detection method that detects primary signal based on the sensed energy. Cyclostationary detection and energy detection techniques are compared with matched filter detection which is difficult to use. The main idea is to measure the probability of fortunate access and corresponding delay of SU in cognitive radio network. Finally the found that energy detection technique is superior than cyclostationarydetection[8].

Ad hoc networks are dynamic in nature and it does not have centralized spectrum sensing. Therefore cognitive radio ad hoc networks need fully distributed cooperative spectrum sensing. Author has proposed gradient based fully distributed cooperative spectrum sensing in cognitive radio. The simulation result shows that proposed scheme does not require any priory knowledge about the network thereby saving energy consumption. Proposed scheme can achieve the performance as good as the consensus based scheme with less energy consumption [9].

To tackle channel detecting issues for single and multiple secondary users (SUs) systems which are successfully demonstrated utilizing limited state Markovian procedures. To a specific address various secondary users case, the model incorporates the altered ppersistent get to (MPPA) convention. To relieve the issue of abnormal state impact among the optional clients a p-determined irregular get to (PPRA) convention is considered, which offers higher normal throughput for auxiliary clients by appropriating their heaps among all channels. Therefore, this brings down the contention among optional clients for getting to same directs and thus offers higher normal throughput[10].

III. CONCLUSION

In this paper various spectrum sensing methods are discussed. Cooperative spectrum sensing is more efficient method. The performance of distributed spectrum sensing and centralized spectrum sensing is studied in terms of probability of missed detection and probability of false alarm. Also the detection techniques are studied and compared. Cyclostationary detection provides lower false alarm but delay access is higher. Energy detection method is simple to use but requires sensing time taken to achieve a given probability of detection may be high. The local spectrum sensing is energy based spectrum sensing. Cooperative spectrum sensing detection performance is often compromised with multipath fading, shadowing and receiver uncertainty issues. To mitigate the impact of these issues, cooperative spectrum sensing is an effective method to improve the detection performance by exploiting spatial diversity. Cognitive radio is an intelligent radio wireless communication technology in order to increase the spectrum efficiency.

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