REVIEW PAPER ON THROUGHPUT OPTIMIZATION AND SPECTRUM SENSING IN COGNITIVE RADIO

PRATEEKSHA SAXENA[1], PRAVEEN PATIDAR[2]

[1]M .Tech (Student) [1], Department of Electronics and Communication Engineering[1], Lakshmi Narain College of Technology, Indore (M.P.), India
[2]Professor[2], Department of Electronics and Communication Engineering[2], Lakshmi Narain College of Technology, Indore (M.P.), India

---

Abstract- *With rapid evolution in wireless devices increases the demand for radio spectrum. We know that the radio spectrum is very valuable and limited natural resources. However, a fixed spectrum assignment has lead to portion of licensed spectrum is not effectively utilized. To solve spectrum underutilization problem cognitive radio technology is introduce. Cognitive radio technology is a promising next generation technology which provides a novel way to allows non license user to use electromagnetic spectrum without interfacing license user (primary user). Ones sensing is done, then the distribution of spectrum among the unlicensed user (secondary user) is also challenging task. Optimizing is the process to find best solution among the available solution. In order to soundly and sharply detect spectrum hole in cognitive radio, optimization must be used. In this paper we studies different optimization algorithm for spectrum sharing and searching in cognitive radio. Also study of its parameters.*

Key Words: **Cognitive Radio, Spectrum sensing, Optimization, Throughput, Particle swarm optimization.**

1. INTRODUCTION

The last decade has witnessed the increasing popularity of wireless services, which increase the shortage of spectrum resources. Radio spectrum is a part of the electromagnetic spectrum. Generally electromagnetic spectrum is regulated by governmental bodies (Federal Communication Commission). The recent report by the United States of America *(USA)* (Federal Communication Commission) has shows that 70% of the license spectrum in United State is not utilized [1]. Than it is observed that the spectrum is not utilize by the license user (primary user) and some of the holes (white space) is vacant. So, it is extremely necessary that the spectrum should be utilized efficiently [2]. Further, time scale of spectrum occupancy varies from millisecond to hours [1]. Because of confined in radio resources the spectrum management, controlling issue and monitoring are the primary objective of wireless communication countrywide as well as worldwide. This motivates the concept of spectrum reuse that allows secondary user to utilize the radio spectrum to the primary user when the spectrum is temporally not being utilized. The core technology behind spectrum reuse is cognitive radio [3], [4].

1.1 Concept of cognitive radio

Cognitive radio techniques can be used to provide a promising solution to increase the spectrum utilization with superiority. Cognitive user is secondary user. The main principle of cognitive user is to use the spectrum when the licensed users (primary users) are not using it. In 2004, FCC has allowed cognitive users to use the unlicensed spectrum [2]. For the upcoming Institute of Electrical and Electronics Engineers (IEEE) 802.22 standard, it is require for the unlicensed user to detect TV signal and wireless microphone signal and vacant the channel within the two seconds ones they become active [5].Further for TV signal detection, it is required to achieved 90% probability of detection and 10% probability of false alarms at signal to noise ratio (SNR) level as low as -20db [5].

1.2 Cognitive radio technicalities

1. Spectrum Hole- Available free spectrum of primary user.
2. Primary User- It is a license user.
3. Secondary User- It is an unlicensed user.

1.3 Functions of cognitive radio

1. Spectrum Sensing- It is the processes in which detect the portion of free spectrum of the license spectrum.
2. Spectrum Management/Decision- It is the process to select the best available, suitable spectrum which is fulfills the communication requirement of the user.
3. Spectrum Sharing- It is the process in which coordinate access to this channel with other users.
4. Spectrum Mobility- In which vacant the channel when license user (primary user) is detected.

A. Throughput

Throughput is the amount of data transfer successfully from primary user to secondary user in cognitive radio. Throughput is study and optimize by varying licensed user (primary user). We always tried to minimize the throughput by using different algorithms. Also study about probability of detection and probability of false alarms.

Depending on the idle state or busy state of the primary user, with the presence of the noise, the signal detection at the secondary user can be modeled as a binary hypothesis testing problem, given as

I. Probability of detection- Hypothesis 0 (H0): (signal is absent) Hypothesis zero means signal of primary user is absent and called probability of detection (P_D) of the signal.

II. Probability of false alarms-Hypothesis 1 (H1): (signal is present) Hypothesis one means signal of primary user is present and called probability of false alarms (P_{FA}) of the signal.

B. Optimization

Optimization is the process in which we select the best output of any circumference. Various algorithms are available for solving numeric optimization problems. These algorithms divided into various group for example- population based (which maintain an entire set of candidate solution for an optimization problem), iteration based and stochastic based. There are two main group of population algorithm first is evolutionary algorithm (EA), second is swarm intelligence based algorithm [6]. In this paper we study both genetic algorithm and particle swam optimization.

2. GENETIC ALGORITHM

A genetic algorithm has broad evolutionary algorithm that models biological process to solve highly complex numeric computational problem to find optimal solution [7]. It is inspired by the evolution of populations from natural genetics. Genetic algorithm is applied to spectrum optimization in cognitive radio networks [8]. Genetic algorithm uses Darwin's theory of 'survival of the fittest' (the fittest object or element survives and the unfit element is disqualified) [2]. The advantage of genetic algorithm is expeditiously to cover large space for the possible configuration and flexible. Genetic algorithm has four main operations: initializations, selection, cross over and mutation [8]. In this paper we have describe crossover and mutation.

- Crossover- crossover is the process in which two selected chromosomes/ populations are combined and generate an offspring. The main concept behind this process is that an offspring is better qualities then its parents [8].
- Mutation- mutation is the very important and last step of genetic algorithm. In this process it modifies chromosome (parents) pattern and random change the individual (which gets by crossover process) chromosome. If we achieved target the process is stop otherwise repeat this step agar until the best result is not achieve.

3. PARTICLE SWARM OPTIMIZATION (PSO)

A popular swarm intelligence based algorithm is particle swam optimization (PSO) algorithm that solve optimization problem. It is population based optimization technique which inspired by social behavior of bird flocking and fish schooling [6]. It is use to optimize sensing time. Particle swarm optimization there is lot of particle in search space having randomly assigned initial population and velocity. Each particle is known as individual and population of all particles is called swarm, particle swam optimization has two main feature first is position second is velocity, these are change according to number of iteration and assign best value of position and velocity on each iteration into the current value of particle [6]. Particle swam optimization is simple, fast and solve the problem of computational iteration. By comparing particle swam optimization to Genetic algorithm observe that genetic algorithm required more operations to perform than particle swam optimization [7].

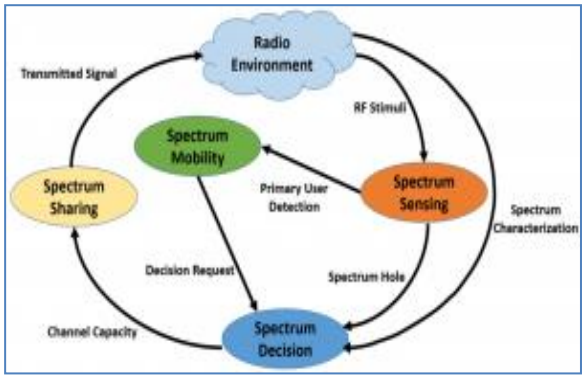

Fig 1: Cognitive radio cycle

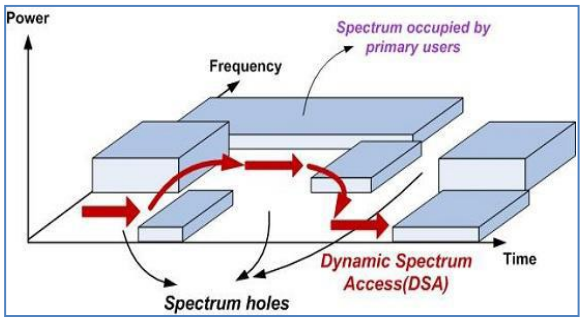

Fig -2: White Space concept

4. LITERATURE SURVEY

[1] Yonghong Zeng et al. "A Review on Spectrum Sensing for Cognitive Radio: Challenges and Solutions" Hindawi Publishing Corporation EURASIP Journal on Advances in Signal Processing Volume 2010, Article ID 381465, 15 pages, In this paper, spectrum sensing techniques from the optimal likelihood ratio test to energy detection, matched filtering detection, cyclostationary detection, Eigen value -based sensing, joint space-time sensing, and robust sensing methods are reviewed. Cooperative spectrum sensing with multiple receivers is also discussed. Special attention is paid to sensing methods that need little prior information on the source signal and the propagation channel. Practical challenges such as noise power uncertainty are discussed and possible solutions are provided. Theoretical analysis on the test statistic distribution and threshold setting is also investigated.

[2] Danijela Cabric et al. "Implementation Issues in Spectrum Sensing for Cognitive Radios",2004 IEEE, pp. 772-776. This places severe requirements on sensitivity, linearity, and dynamic range of the circuitry in the RF front-end. To improve radio sensitivity of the sensing function through processing gain we investigated three digital signal processing techniques: matched filtering, energy detection, and cyclostationary feature detection. Our analysis shows that cyclostationary feature detection has advantages due to its ability to differentiate modulated signals, interference and noise in low signal to noise ratios.

[3] Payal Mishra et al. "Survey on Optimization Methods for Spectrum Sensing in Cognitive Radio Network" International Journal of New Technology and Research (IJNTR) ISSN: 2454-4116, Volume-1, Issue-6, October 2015 Pages 23-28. In this paper we study different optimization for spectrum searching and sharing and also compare this optimization on the basis of probability of total error on fading channel.

[4] Ying-Chang Liang "Sensing-Throughput Trade-off for Cognitive Radio Networks" IEEE Transactions on Wireless Communications, Vol. 7, NO. 3 MARCH 2008. In this paper, we study the problem of designing the sensing duration to maximize the achievable throughput for the secondary network under the constraint that the primary users are sufficiently protected. We formulate the sensing-throughput trade off problem mathematically, and use energy detection sensing scheme to prove that the formulated problem indeed has one optimal sensing time which yields the highest throughput for the secondary network. Cooperative sensing using multiple mini-slots or multiple secondary users are also studied using the methodology proposed.

[5] Rahul Tandra et al."SNR Walls for Signal Detection" IEEE Journal of Selected Topics in Signal Processing, Vol. 2 (1), Feb 2008. This paper considers the detection of the presence/absence of signals in uncertain low SNR environments. Small modelling uncertainties are unavoidable in any practical system and so robustness to them is a fundamental performance metric. The impact of these modelling uncertainties can be quantified by the position of the "SNR wall" below which a detector will fail to be robust, no matter how long it can observe the channel. We propose simple mathematical models for the uncertainty in the noise and fading processes. These are used to show what aspects of the model lead to SNR walls for differing levels of knowledge of the signal to be detected.

5. CONCLUSION

In this paper different circumstances and condition are studies. For each case of study we obtained maximum throughput by optimized at low signal to noise ratio and the necessary condition of probability of detection and probability of false alarms. Some algorithm also studies. It is observed that the value of different parameters is very close by using algorithm. So we enhanced the performance of cognitive radio by use these algorithms.

REFERENCES

[1] Y.C.Liang, Y.Zeng, E.C.Y.Peh, and A.T. Hoang, "Sensing Throughput trade-off for cognitive radio networks" IEEE Transaction on Wireless Communications, Vol.7 (4), Pp.1326-1337, 2008.

[2] R. Deka, S. Chakraborty, and J.S. Roy, "Optimization of Spectrum sensing in cognitive radio using genetic Algorithm", Facta Universitatis, Ser: Elec. Energ. Vol. 25(3), pp. 235-243, 2012.

[3] D. Cabric, S. M. Mishra, and R. W. Brodersen, "Implementation issues in spectrum sensing for cognitive radios," in Proc. Asilomar Conference on Signals, Systems and Computers, Pacific Grove, CA, USA, 7 – 10 Nov. 2004, pp. 772 – 776K. Elissa, "Title of paper if known," unpublished.

[4] R. Tandra and A. Sahai, "SNR walls for signal detection," IEEE J. Sel. Topics Signal Process, Vol. 2 (1), pp. 4 – 17, Feb. 2008.

[5] Y Zeng, Y C Liang, A T Hoang and R Zhang. "A review on spectrum sensing for cognitive radio challenges and solution" Hindawi Publishing corporation EURASIP journal on advances in signal processing doi:10.1155/2010/381465.

[6] P Mishra and N Dewangan."Survey on optimization methods for spectrum sensing in cognitive radio network" International journal of new technology and research (IJNTR) ISSN: 2454 4116, Vol. 1(6), October 2015, pages 23-28.

[7] J. Elhachmi, and Z. Guennoun, ”Cognitive radio spectrum allocation using genetic algorithm”, Elhachmi, and Guennoun EURASIP Journal on Wireless Communications and Networking, vol.2016,pp.133-143,2016.

[8] P. Supraja and R. Pitchai "optimized neural network for spectrum prediction using genetic algorithm in cognitive radio network", Springer Science Business Media, LLC, Part of Springer nature 2018.