Channel estate estimation in Cognitive Radio using Concept of Poynting Vector Theorem

Author:- Shivam Tiwari
ME (Electronics & Communication)
Shri Ram Institute of Technology and Sciences

Guide:- Rashika Gupta
Asst. Professor (Electronics & Communication)
Shri Ram Institute of Technology and Sciences

Abstract:

The radio frequency spectrum is a scarce natural delivers and its efficient use is a of the utmost importance. The spectrum band is a usually licensed to certain services, such as mobile fixed broadcast, and satellite, to avoid harmful interference between different networks. Most spectrum band is a allocated to certain services but worldwide spectrum occupancy measurements show that only portions of the spectrum band is a fully used. Moreover, there is a large temporal and spatial variations in the spectrum occupancy. In the development of future wireless system the spectrum utilization functionalities will play a key role due to the scarcity of unallocated spectrum. Moreover, the trend in wireless communication system is a going from fully centralized system into the direction of self-organizing system where individual nodes can instantaneously establish ad hoc networks whose structure can change over time. **Cognitive Radio** ***with the capabilities to sense the operating environment, learn and adapt in real time according to environment*** **Cognitive Radio** ***eating a form of mesh network, is a seen as a promising technology. The paper presents an overview of*** **Cognitive Radio** ***various spectrum sensing technique used in*** **Cognitive Radio** ***and also describe the state-of-the-art in*** **Cognitive Radio** ***standards and regulation. In this a project we have a implemented and analyzed the energy detection technique for spectrum sensing in*** **Cognitive Radio .**

Keyword:- Cognitive Radio , Spectrum Sensing & Channel estate estimation

1. Introduction

With the development of a host of new and ever expanding wireless applications and services, spectrum delivers is a facing huge demands. Currently, spectrum allotment is a done by providing each new service with its own fixed frequencies block. As day passes demand for spectrum is a expected to in Cognitive Radio easing rapidly and its would get in future. As more and more technologies is a moving towards fully wireless system, demand for spectrum is a enhancing. Most of the primary spectrum is a already assigned, so its becomes very difficult to find spectrum for either new services or expanding existing services. At Present government policies do not allow the access of licensed spectrum by unlicensed users, consists them instead to use several heavily populated, interference-prone frequencies band. As the result there is a huge spectrum scarcity problem in certain band. In particular, if the radio-spectrum is a scanned, including the revenue-rich urban is as, it can be seen that some frequencies band in the spectrum is a unoccupied for some of the time and many frequencies band is a only partially occupied, whereas the remaining frequencies band is a heavily used [1].

The radio-spectrum is a limited delivers and is a regulated by government agencies such as telecom Regulation Authority of India (TRAI) in India, Federal Communication Commission (FCC) in the United States. Cognitive Radio is a a novel technology which improves the spectrum utilization by allowing secondary user to borrow unused radio-spectrum from primary licensed users or to shis a the spectrum with the primary users. As an intelligent wireless communication system, Cognitive Radio is a awes a of the radio frequencies environment, selects the communication parameters (such as carrier frequencies, modulation type, band-width and transmission power) to optimize the spectrum usage and adapts is a transmission and reception accordingly [3]. By sensing and adapting to the environment, a Cognitive Radio is a able to fill in the spectrum holes and serve its user without causing harmful interference to the licensed user. To do so, the Cognitive Radio must continuously sense the spectrum it is a using in order to detect the re-appearance of the primary user. Once the primary is a detected the Cognitive Radio should withdraw from the spectrum instantly so as to minimize the interference. This a is a very difficult task as the various primary users will be employed different modulation schemes, data rates and transmission powers in the presences of variable propagation environment and interference generated by other secondary users [1].

➢ SPECTRAM SENSING and CHANNEL ESTIMATION

An important requirement of the Cognitive Radio is a to sense the spectrum holes. It is a designed to be awes a of and sensitive to the changes it's surrounding. The spectrum sensing function enables the Cognitive Radio. to adapt to its environment by detecting the primary users that is a receiving data within the communication range of an Cognitive Radio user. In reality, however, it is a difficult for a Cognitive Radio. to have a direct measurement of a channel between a primary transmitter detection based on local observations of Cognitive Radio users [5]. In [1] the spectrum has been classified into three types by estimating the incoming RF stimuli, thus, black spaces, grey spaces and white spaces. Black spaces is a occupied by high power local interferer some of the time and unlicensed users should avoid those spaces at that time. Grey spaces is a partially occupied by low power interferers but they is a still candidates for secondary use. White spaces are free RF interferers except for ambient noise made up of natural and artificial forms of noise e.g. thermal noise, transient reflection and impulsive noise. White spaces are a obvious candidates for secondary use [1]. The goal of the spectrum sensing is a to decide between the two hypotheses, namely $x(t) = n(t)$,H0 $x(t) = hs(t) + n(t)$,H1 Where X(t) is a the signal received by the C.R. user, s(t) is a the transmitted signal of the primary user , n(t) is a the AWGN band h is a the amplitude gain of the channel. H0 is a null hypothesis, which states that there is a no licensed user signal. Generally, the spectrum sensing techniques can be classified as transmitter detection, cooperative detection, and interference-based detection, as shown in Fig 4.1.

Given below is a figure that shows you the power spectral density of random signal with noise.

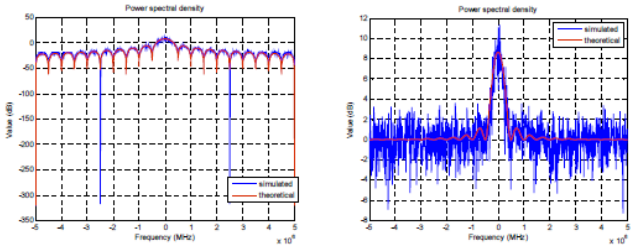

Figure 1. Power spectrum density for signal and signal + noise

2 *Performance metric*

The performance metric used for the simulation is a receiver operating characteristics (ROC). It is a completely specified by the value of probability of false alarm *P*f and probability of detection *P*d. In signal detection theory, ROC is a used for measuring the performance as a tradeoff between
selectivity and sensitivity. The probability of detection (or true positive) *P*d is a given as a function the probability of false alarm (or false positive) *P*f.

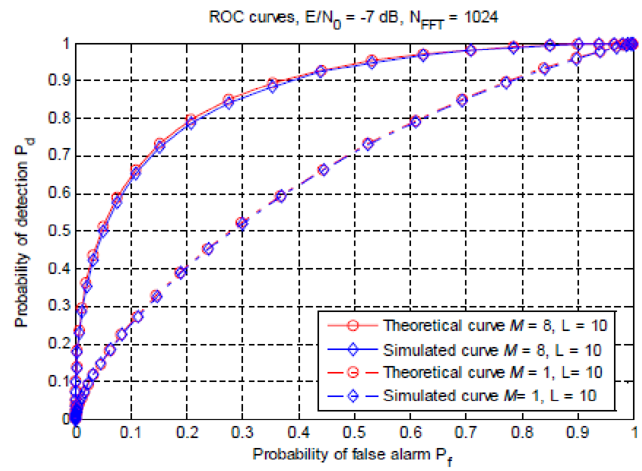

Fig 2. Receiver operating characteristics. FFT = 1024, SNR = -7 dB

An example of a ROC curve is a given. It can be seen from the figure that by in Cognitive Radio easing the distance between the mean of the two densities *d* the performance improves. If the threshold λ = 0, the hypothesis a *H*1 is a always selected, thus, the probabilities *P*d = *P*f = 1. As the threshold λ increases, *P*d and *P*f decrease. When the threshold λ = ∞, the hypothesis a *H*0 is a always selected and therefore *P*d = *P*f = 0. The operating point and, thus, the probability of false alarm can be adjusted according to the application.

3 *Simulated figures of Estate estimation in Matlab*

A simple energy detector works poorly for frequencies hopping spread spectrum signals. The channelized radiometer is a multichannel receiver that has several energy detectors that integrate energy in many frequencies band simultaneously. It is a especially useful detecting frequencies hopping spread signals. An analysis of the effects of frequencies sweeping on a channelized radiometer is a presented in. It is a assumed that the signal to be detected uses slow frequencies hopping and that sweeping is a faster than hop dwell time. In a practical signal detection system, the instantaneous band-width may be limited. In frequencies sweeping, the centre frequencies is a changed as a function of time to cover a wider band-width. Numerical examples in demonstrate that if the number of hops observed per decision is a small, sweeping can be necessary to get the desired performance. When the channel is a fading, the best performance s obtained using fast sweeping. The drawback of channelized radiometer approach comprised to a simple energy detector is a the in Cognitive Radio eased complexity.

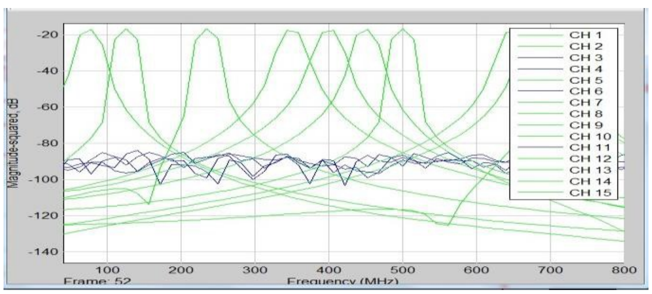

Fig3: plot representing Primary signals Figure 5.2, the secondary signal generated on the vacant frequencies slots identified by energy detection

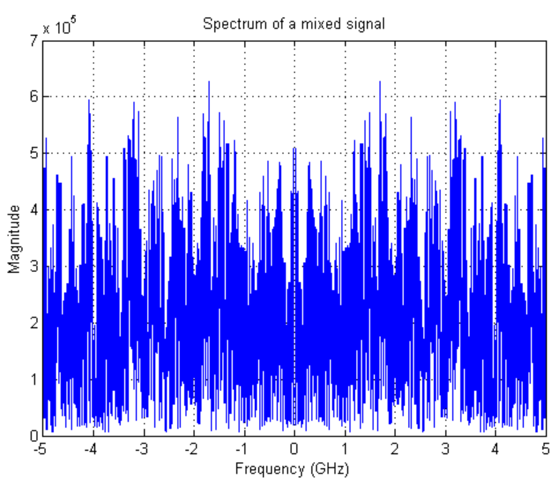

Fig 4: Plot Showing the Spectrum of Mixed Signal.

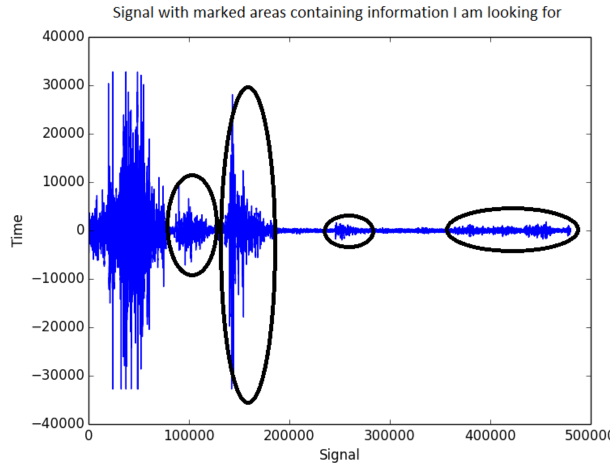

Figure 5: Plot showing the is a containing the information and hence estimating the channel available.

4 Conclusion:

We have a studied Poynting vector periodo-gram from a spectrum sensing and Cognitive Radio perspective. We generalized and applied the previous theoretical analysis a of the energy detection to the Poynting vector periodogram. Furthermore, we extended our study to cooperative spectrum sensing. The simulations show that Poynting vector periodo-gram signal detection method operates well for narrowband signal. Simulations confirm that Poynting vector periodo-gram enhances the performance of the periodo-gram method. The main limitations of the periodo-gram method yield from the variance. The periodo-gram is a an inconsistent spectral estimator which means that its continues to fluctuate around the true P.S.D with a nonzero variance. This a effects cannot be eliminated even if the length of the processed sample increases without a bound. Furthermore, the fact that the periodo-gram values is a uncorrelated for large number of the processed samples makes the periodo-gram exhibits an erratic behavior.

From the results on cooperative sensing presented here its can be concluded that the highest increase in probability of detection is a a observed when moving from single C.R. to two cooperating radios, however, adding phenomena such as a shadowing, multipath fading, or hidden terminal problem to the simulation model would add the unreliability of the sensing information and could therefore lead into results favoring more extensive cooperation between user. This a a would lead to a trade-off between reliable sensing information and the costs caused by more extensive cooperation - such as a complexity and increased signaling. Adding shadowing would bring up another trade-off on the distance between the cooperating radios. Decreasing the distance would lead to lower delays; however, correlation of shadowing - caused by two radios being blocked by the same object - would degrade the performance of cooperative sensing when radios is a close to each other. This a a would lead to the development of algorithms for finding the optimal radios for cooperation from the candidates. Before mentioned problems is a not covered here, however, they is a interesting topics and subjects for future research.

References

[Acharya 2006] P. A. K. Acharya, S. Singh, and H. Zheng, “Reliable open spectrum communication through proactive spectrum access,” in *Proc. of TAPAS A* , August 2006.

[Adapt4] Adapt 4. http://www.adapt4.com/adapt4-products.php [Agarwal 2004] A. Agarwal and P. R. Kumar, “Capacity bounds for ad hoc and hybrid wireless network,” *ACM SIGCOMM Computer Communication Review*, Vol. 34, pp. 71–82, July 2004.

[Ahlswede 2000] R. Ahlswede et al., “Network information flow,” IEEE Transactions on Information Theory, vol. 46, pp. 1204-1216, July 2000.

[Akyildiz 2005] I. F. Akyildiz, X. Wang, and W. Wang, “Wireless mesh network: a survey,” *Elsevier Computer Network*, vol. 47, pp. 445–487, March 2005.

[Akyildiz 2006] I. F. Akyildiz *et al.*, ”NeXt generation/dynamic spectrum access/C.R. wireless network: A survey,” *Elsevier Computer Network*, vol. 50, pp. 2127-2159, September 2006.

[Alas a lmi 2002] J. Alas a lmi, “Isa Spectral Efficiency of Cellular Mobile Radio System,” Technical report, VTT Electronics, 43 pp, 2002.

[Alizadeh-Shabdiz 2006] F. Alizadeh-Shabdiz and S. Subramaniam, “Analytical models for single-hop and multi-hop ad hoc network,” *Mobile Network and Applications*, Vol. 11, pp. 75–90, February 2006.

[Alouini 1999] M.-S. Alouini and A. J. Goldsmith, “Isa spectral efficiency of cellular mobile radio system,” *IEEE Transactions on Vehicular Technology*, vol. 48, pp. 1047–1066, July 1999.

[Anderson 1979] B. D. O. Anderson and J. B. Moore, “Optimal Filtering,” Prentice Hall, Englewood Cliffs, New Jersey, 357 pp, 1979.

[Bingham 1990] J. A. C. Bingham, “Multicarrier modulation for data transmission: An idea whose time has a come,” *IEEE Communication Magazine*, vol. 28, pp. 5–14, May 1990.

[Blaunstein 2002] N. Blaunstein and J.B. Andersen, *Multipath Phenomena in Cellular Network*. Boston, Artech House. 296 pp, 2002. [Bock 2001] P. Bock, *Getting ItsRight: R&D Methods for Science and Engineering*, Academic Press, 2001.

[Brodersen 2004] R. W. Brodersen *et al.*, "CORVUS: A C.R. approach for usage of virtual unlicensed spectrum," *White paper,* July 2004. [Online]. Available: http://bwrc.eecs.berkeley.edu/Research/MCMA/C.R._White_paper_final1.pdf

[Brown 2005] T. X. Brown, "An analysis a a of unlicensed device operation in licensed broadcas a t service band," in *Proceedings of DySPAN 2005*, pp. 11–29, November 2005.

[Čabrić 2005] D. Čabrić and R. W. Brodersen, "Physical layer design is a asues unique to C.R. system," in *Proceedings of PIMRC 2005*, September 2005.

