*Impact Factor (SJIF): 4.542*

**International Journal of Advance Research in Engineering, Science & Technology**

*e-ISSN: 2393-9877, p-ISSN: 2394-2444*

***Volume 4, Issue 4, April-2017***

# Brief analysis of Energy detection method based spectrum sensing in cognitive radio

**Akshaykumar Odhavjibhai Bhadja[1], Shilpa Rana[2]**

*[1]PG student, Eectronics & Communication Engineering, LDCE, Ahmedabad*
*[2]Assistant Professor, Eectronics & Communication Engineering , LDCE, Ahmedabad*

***Abstract — Cognitive radio is a wireless communication system that is aware of its environment. It can change parameters according to spectrum requirement. Various techniques provide the capability to use or share the spectrum in an opportunistic manner. The major functions of cognitive radio have spectrum sensing, spectrum management, spectrum mobility and spectrum sharing. Spectrum sensing is the major task, which is used by all the Cognitive radio users to harvest the advantage of Cognitive radio technique. In this paper spectrum sensing method such as energy detection is implemented. The main aim of this paper is to classify the techniques based on the key parameters such as probability of detection, probability of false alarm and signal to noise ratio using MATLAB.***

**Keywords- Cognitive radio, Spectrum sensing, Energy detection, Matched filter.**

## I. INTRODUCTION

Today's wireless systems are regulated by a fixed spectrum assignment policy, i.e. the spectrum is regulated by government agencies and is assigned to license holders or services on a long term basis for large geographical regions. In addition, a huge portion of the assigned spectrum is used sporadically. The spectrum usage is concentrated on some portions of the spectrum while a significant amount of the spectrum remains unutilized. The limited available spectrum and the inefficiency in the spectrum usage necessitate a new communication model to exploit the existing wireless spectrum opportunistically. Dynamic spectrum access is used to solve current spectrum inefficiency problems. The key enabling technology of Next Generations networks is the cognitive radio. Cognitive radio techniques provide the capability to use or share the spectrum in an opportunistic manner. Dynamic spectrum access techniques allow the cognitive radio to operate in the best available channel.

According to FCC: "Cognitive radio: A radio or system that senses its operational electromagnetic environment and can dynamically and autonomously adjust its radio operating parameters to modify system operation, such as maximize throughput, mitigate interference, facilitate interoperability, access secondary markets." One of the most important components of the cognitive radio concept is the ability to measure, sense, learn, and be aware of the parameters related to the radio channel characteristics, availability of spectrum and power, radios operating environment, user requirements and applications, available networks (infrastructures) and nodes, local policies and other operating restrictions. In cognitive radio those who have higher priority are referred as Primary user (PU), it has its own licensed band. Whereas low priority given to the secondary user (SU) which does not have licensed to use that spectrum unless permission from PU is not provided. The impact on the primary system, for example in terms of increased interference, must be kept at a minimum level. Therefore, cognitive radios must sense the spectrum to detect whether it is available or not and must be able to detect weak primary user signals. The introduction of cognitive radios inevitably creates increased interference and thus it can degrade the quality of service of the primary system.

## II. ENERGY DETECTION BASED SPECTRUM SENSING METHOD

If CR can't have sufficient information about primary user's waveform, then the matched filter is not the good selection. However if it is aware of the power of the random Gaussian noise, then energy detector is good choice. The authors proposed the energy detector as shown in Figure 1. The input band pass filter(BPF) selects the centre frequency fs and bandwidth of interest W. The filter is followed by a squaring device to measure the received energy then the integrator determines the observation interval, T. Finally the output of the integrator, Y is compared with a threshold, λ to decide whether primary user is present or not.

In a non fading environment where h is amplitude gain of the channel, probability of detection Pd and probability of false alarm Pf are given by following formulas:[2,9]

$$Pd = P(Y > \lambda \mid H1) = Qm\left(\sqrt{2\Upsilon}, \sqrt{\lambda}\right) \quad \text{.....1}$$

$$Pf = P(Y > \lambda \mid H0) = \Gamma\left(m, \frac{\lambda}{2}\right) / \Gamma(m) \quad \text{.....2}$$

Where Y is the SNR, m = TW is the (observation/sensing) time bandwidth product. Γ (.) and Γ (.,.) are complete and incomplete gamma functions, $Qm$ ( ) is the generalized Marcum Q-function.

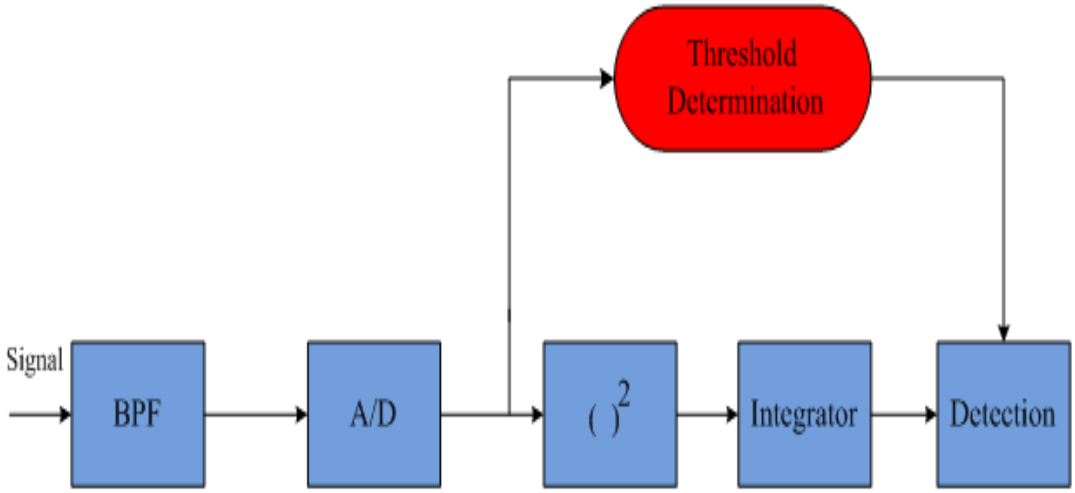


Figure. 1. Energy detection based spectrum sensing

In case of a fading average probability of detection may be derived by averaging over fading statistics:

$$Pd = \int xQm(\sqrt{2}\Upsilon,\sqrt{\lambda})\mathrm{f}\Upsilon(\mathrm{x})\mathrm{dx}.....3$$

Where f γ (x) is the probability distribution function of SNR under fading.

In a fading environment h is the amplitude gain of the channel that varies due to the fading effect which makes the SNR variable. Pf is the same as that of non Fading case because Pf is independent of SNR. Pd gives the probabability of detection conditioned on instantaneous SNR.

A low value of Pd (Probability of detection) indicates an absence of primary user with high probability; it means that the CR user can use that spectrum. A high value of Pf denotes minimum use of spectrum.

In the paper suggest that in fading environment, where different CR users need to cooperate in order to detect the presence of the primary user. In such a scenario a Comprehensive model relating different parameters such as detection probability, number and spatial distribution of spectrum sensors and more importantly propagation characteristics are yet to be found.

Energy detector which is also known as periodogram. It is general way of spectrum sensing because of its less computation and less complexity of implementation. It is more generic way as receivers do not need any kind of prior knowledge of primary user's signal. The signal is detected with comparison of the output of the energy detector with a threshold which depend on the noise figure. Challenges of energy detector is based on sensing include threshold selection for detecting primary users, but have in-ability of differentiating from primary user. Also has poor performance under low SNR values. Moreover, energy detectors do not work efficiently for detecting spread spectrum signals. Probability of detection under AWGN channel can be evaluated as:

$$P_D = Q_D(\sqrt{2\Upsilon},\sqrt{\wedge}).$$

Where, $P_D$ is the probability of detection. $Q_D$ is the Marcum-Q Function, $\Upsilon$ is the Signal to Noise ratio, $\wedge$ is the Decision threshold.

## III. SIMULATION RESULTS

Energy detection method is a basic and primary method. Here we take various cases of SNR under AWGN channel. We varies the value of SNR and we get three different values of curves: simulation, theoretical and approximation results. Simulation method is conventional method. Threshold value is taken from Digham research paper 2003.While approximation method is based on chi-square Gaussian formula in MATLAB. In results we denoted Pm as probability of missed detection, Pf as probability of false alarm.

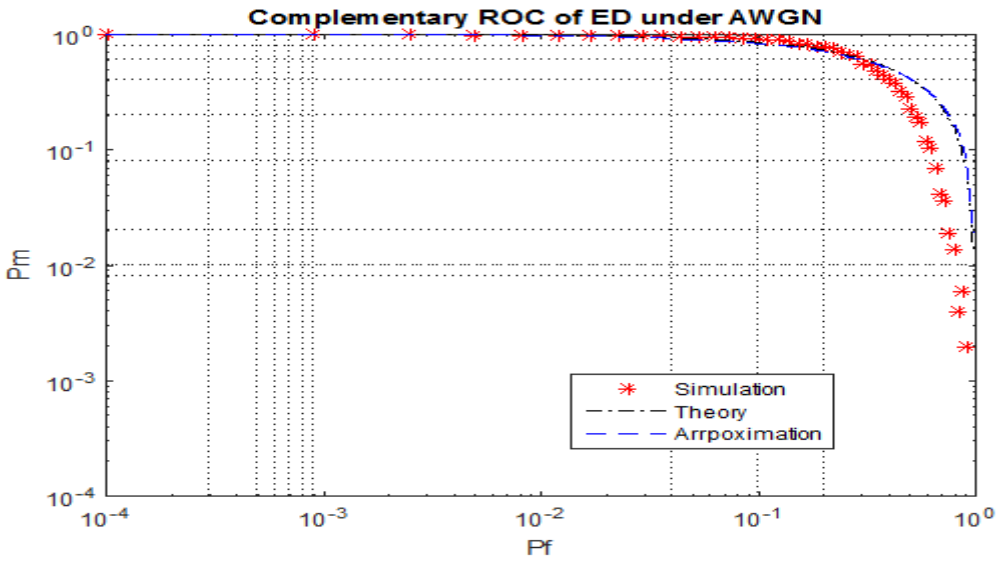


Figure 2. At SNR= -10 dB comparison of simulation, Theory and approximation value of ED under AWGN.

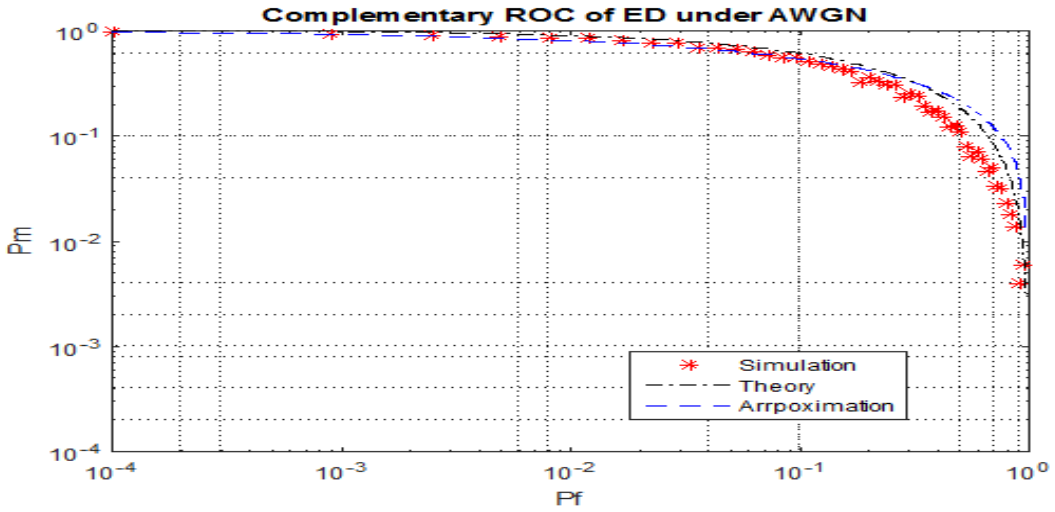


Figure 3. At SNR= -3 dB comparison of simulation, Theory and approximation value of ED under AWGN.

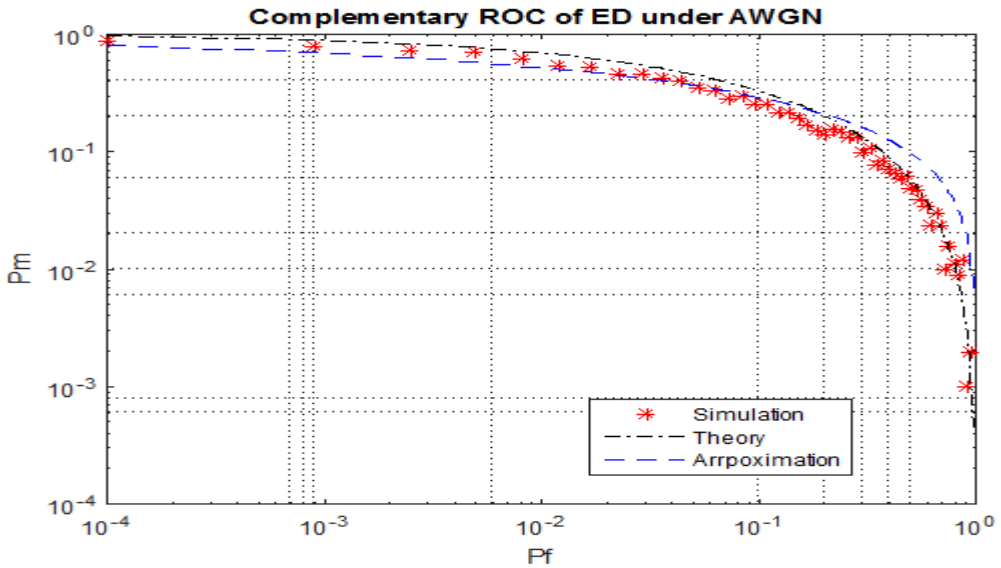


Figure 4. At SNR= 0 dB comparison of simulation, Theory and approximation value of ED under AWGN

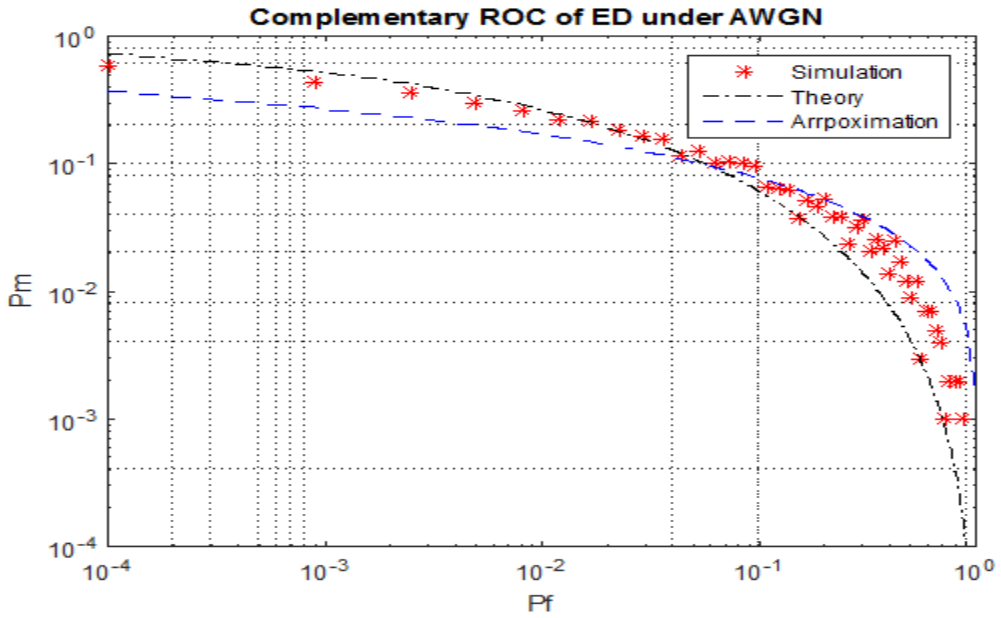


Figure 5. . At SNR= 3 dB comparison of simulation, Theory and approximation value of ED under AWGN

## IV. CONCLUSION

Here we take MATLAB simulation for five SNR values -10, -3, 0, 3, in Decibels. Simulation method is conventional method. Threshold value is taken from Digham research paper 2003.While approximation method is based on chi-square Gaussian formula in MATLAB. As, SNR increase from -10 dB to 10 dB, results are as shown in simulation result probability of missed detection decreases. Thus according to formula Pd= 1-Pm, probability of detection increases accordingly.So energy detection method gives poor result at lower value of SNR. So energy detection method has its limitation at lower SNR. As SNR value increases probability of missed detection decreases.

## REFERENCES

[1] S. Ziafat, W. Ejaz Y, H. Jamal, "Spectrum Sensing Techniques for Cognitive radi Networks: Performance Anlaysis," *978-1-4577-0963-0/11, IEEE,*2011.
[2] Tev_k Yucek and Huseyin Arslan, "A Survey of Spectrum Sensing Algorithms for Cognitive Radio Applications",*IEEE COMMUNICATIONS SURVEYS & TUTORIALS,*VOL. 11, NO. 1, FIRST QUARTER 2009.
[3] Avendaño Fernández Eduardo, René Geovani González Caballero, "Experimental evaluation of Performance for Spectrum Sensing: Matched filter vs Energy detector", *IEEE COLCOM*, 2015.
[4] Fatima Salahdine, Hassan El Ghazi, Naima Kaabouch, Wassim Fassi Fihri, "Matched Filter Detection with Dynamic Threshold for Cognitive Radio Networks" *IEEE*, 2015.
[5] B.Suseela, Dr. D. Sivakumar, " Non-Cooperative Spectrum Sensing Techniques in Cognitive Radio-A Survey*", IEEE International Conference on Technological Innovations in ICT for Agriculture and Rural Development (TIAR 2015).*
[6] Ashish Bagwari and Brahmjit singh, "Comparative performance evaluation of Spectrum Sensing Techniques for Cognitive Radio Networks*", Fourth International Conference on Computational Intelligence and Communication Networks,IEEE*, 2012.
[7] S.Taruna Bhumika, Pahwa Ikpreet kaur,"Assessment of Energy Detection Spectrum sensing Under Different Wireless Channels", AdvanceComputing Conference(IACC), *IEEE International, pp.276-281*, 2014.
[8] Ala Eldin Omer, "Review of Spectrum Sensing Techniques in Cognitive Radio Networks", ***I**nternational **C**onference on **C**omputing, **C**ontrol, **N**etworking, **E**lectronics and **E**mbedded Systems **E**ngineering*, 2015.
[9] Fadel F. Digham, Mohamed-Slim Alouini, and Marvin K. Simon, "On the Energy Detection of Unknown Signals Sover Fading Channels",*IEEE,*2003.
[10] Mohsen Riahi Manesh, Md. Shakib Apu, Naima Kaabouch1 and Wen-Chen Hu, "Performance Evaluation of Spectrum Sensing Techniques for Cognitive Radio Systems",*IEEE,*2016**.**