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A Locally Optimum Detector for Detection of Random Signals under Weakly Correlated Noise over Fading Channels

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ABSTRACT : In order to detect the presence of the primary user signal, spectrum sensing is a fundamental requirement to achieve the goal of cognitive radio (CR). This ensures the efficient utilization of the spectrum and to avoid interference from secondary users to primary holders. This paper addresses the problem of energy detection of on signal in weakly correlated noise over fading channels, By using ROC (receiver operating characteristic) parameters of cognitive radio network such as probability of false alarm, detection probability, mis-detection probability with locally optimum detector.

KEYWORDS: Cognitive radio networks, spectrum sensing, fading channels, locally optimum detection,false alarm , ROC curve , mis-detection probability, energy detection.

I. INTRODUCTION

The usable electromagnetic radio spectrum a precious natural resource is of limited physical extent. However, wireless devices and applications are increasing daily. It is therefore not surprising that we are facing a difficult situation in wireless communications [10]. Moreover, given the reality that, currently, the licensed part of the radio spectrum is poorly utilized, this situation will only get worse unless we find new practical means for improved utilization of the spectrum. Cognitive radio [10], a new and novel way of thinking about wireless communications, has the potential to become the solution to the spectrum underutilization problem .Building on spectrum sensing and other basic tasks, the ultimate objective of a cognitive radio network is twofold:

• provide highly reliable communication for all users of the network, wherever and whenever needed.
• facilitate efficient utilization of the radio spectrum in a fair-minded and cost-effective manner [6].

Based on the interaction with the environment, a cognitive radio signals will change the transmitter parameters. In data transmission, secondary users can sense the spectrum and use spectrum holes dynamically from primary users with the help of cognitive radio signals. Any interference of secondary users are not allowed in primary users frequencies [8]. Therefore secondary users must be aware of the primary user's presence. Primary license holders are detected by their presence and absence with methods like spectrum sensing [3] [1]. The method of spectrum sensing is tedious task as primary users suffer from fading, shadowing, etc. There are other types of spectrum sensing techniques like matched filtering, energy detection, cyclostationari-based detection and Eigen value-based detection In this paper we consider AWGN exhibits correlation significantly In case of correlated noise environments, rather than simple detection techniques we use to implement LO detection techniques [1]. In this paper, we used the ROC curve to compare simple energy detection with locally optimum detection.. It is clear that later has better performance.

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II. PROPOSED METHOD

The two hypotheses assumed are, H_0 in which the primary user is said to be absent and H_1 once the first user is said to be present, the received signal samples (n = 1, 2, . . .,N) at the secondary user for these two types of hypotheses could also be shapely in equivalent complex baseband illustration as [2]:

$$H_0 : x_n = w_n \quad (1)$$

$$H_1 : x_n = hs_n + w_n \quad (2)$$

Where, X_n, h, and W_n denote the received signal, the Rayleigh attenuation channel gain, and also the noise samples at the secondary user and S_n is that the primary user signal. The channel gain h is assumed to be constant throughout the detection method with zero mean and also the variance of $E[|h|^2] = \sigma h^2$. The primary user signal used to has zero mean, variance σs^2, and it's real and unreal elements square measure statistically freelance and has each variance σs^2 /2.The zero mean noise samples square measure assumed to own identical variance σn^2. The element samples square measure assumed to be temporally freelance, identically distributed (i.i.d.). In this paper, we will assume that the weakly dependent noise e_i, i=1,2……,N, are unilateral MA of i.i.d. random variables [1]:

$$W_1 = e_1$$

$$W_n = e_n + \rho e_{n-1}, \ n = 2,\ldots,N,$$

Where $|\rho| < 1$ is the parameter that defines the noise Correlation

III. TEST STATISTIC

In order to derive a test statistic to recognize between two hypothesis H_0 and H_1, we start with the Locally optimal (LO) decision statistic expressed as

$$\Lambda = \frac{p(X|H1)}{p(X|H0)} = E_{h,s}\left[\frac{F_w(X-hS)}{f_{w(X)}}\right] \quad (3)$$

Where f_w is the multivariate pdf of the noise samples and X = x1, . . . , xN, S = s1, . . . , sN. For the hypothesis H1, we have

$$f_w(X\text{-}hS) = f_w(x_1 - hs_{1,\ldots\ldots\ldots} \ x_N - hs_N)$$

$$\Lambda = \sum_{i=1}^{N} \frac{1-\rho^{2i}}{1-\rho^2} |y_i|^2 \quad (4)$$

Where $y_i = \sum_{k=0}^{i-1} (-\rho)^k \ x_{i-k}$

IV. PERFORMANCE PARAMETER

A] probability of detection (P_d) $= Q\left(\frac{\tau-\mu_0}{\sigma_0}\right)$ (5)

B] probability of false alarm (P_f) $= Q\left(\frac{\tau-\mu_1}{\sigma_1}\right)$ (6)

C] probability of mis-detection (P_m) $= 1 - Q\left(\frac{\tau-\mu_0}{\sigma_0}\right)$ (7)

V. ENERGY DETECTION

Test statistics for energy detector can be expressed as

$$\Lambda = \sum_{i=1}^{N} |x_i|^2 \quad (8)$$

$$\Lambda_{|H_0} = \sum_{i=1}^{N} |W_i|^2 \quad (9)$$

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$$\Lambda_{|H_1} = \sum_{i=1}^{N} |hs_i + W_i|^2 \quad (10)$$

VI. PERFORMANCE ANALYSIS

We quantify the receiver performance by depicting the receiver operating characteristic (ROC) (P_d *and* P_f) , or equivalently, complementary ROC (probability of a miss detection P_m = 1-P_d , versus P_f) for different situations of interest [4]. At secondary user a fading channel with weakly correlated noise, N=500 samples are taken. We assumed a slow fading where the fading channel gain h is constant. In order to verify our theoretical analysis, we also find the average false alarm probability using simulations over 100,000 independent realizations of the Rayleigh fading channel and compare with analytical results [1].

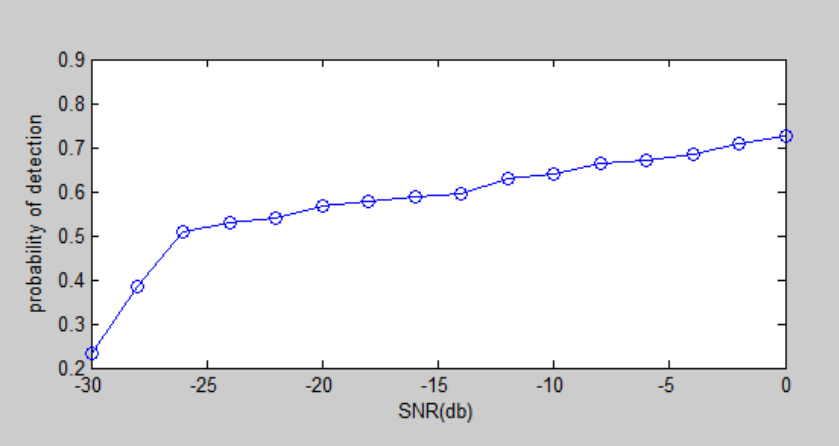

Fig.1. probability of detection for energy detector at ρ = 0.5

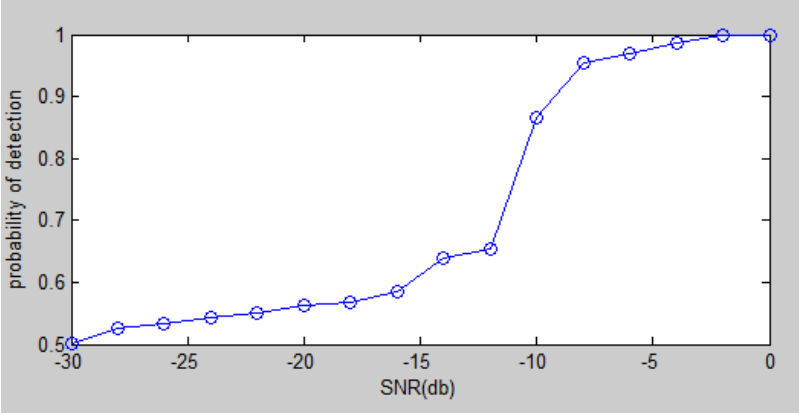

Fig.2. probability of detection for locally optimum detector LO at ρ = 0.5

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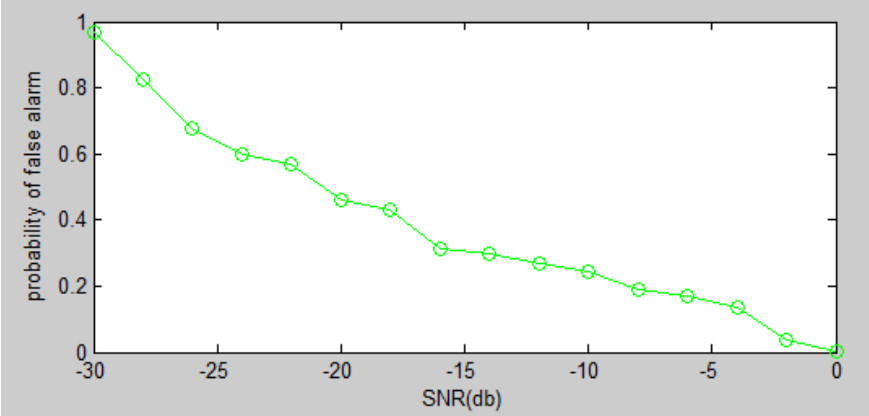

Fig.3. probability of false alarm for energy detector at ρ = 0.5

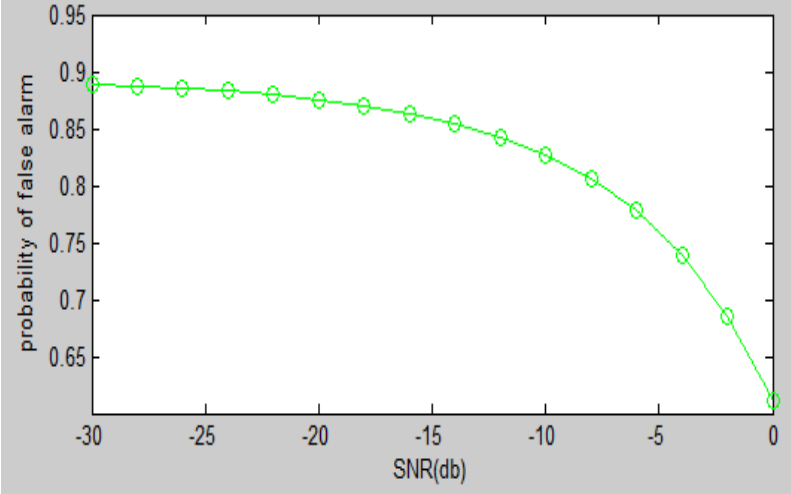

Fig.4. probability of false alarm for locally optimum detector at ρ = 0.5

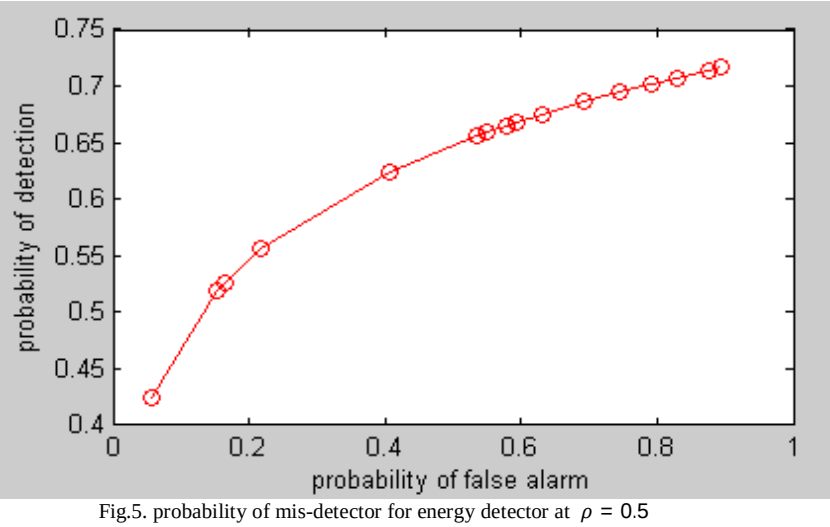

Fig.5. probability of mis-detector for energy detector at ρ = 0.5

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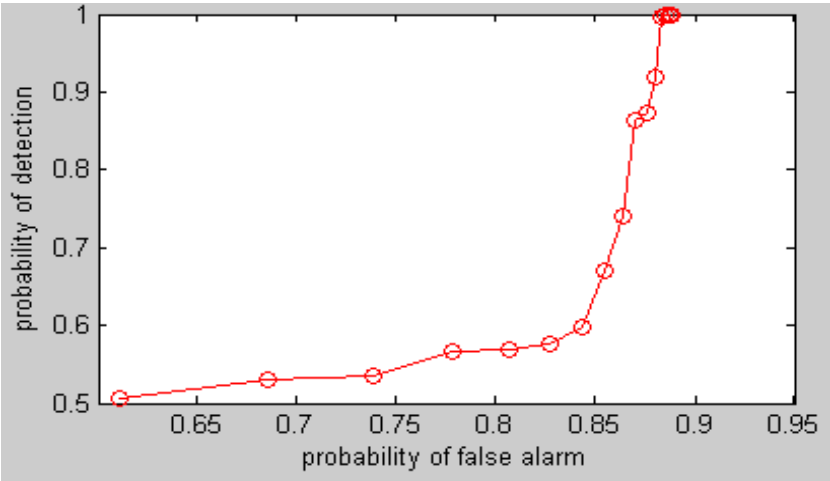

Fig.6. probability of mis-detection for locally optimum detector at ρ = 0.5

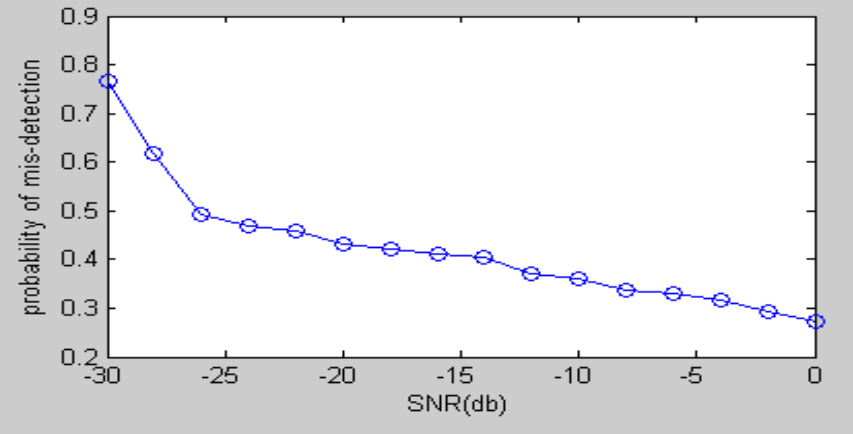

Fig.7. probability of mis-detection Vs SNR for energy detector at ρ = 0.5

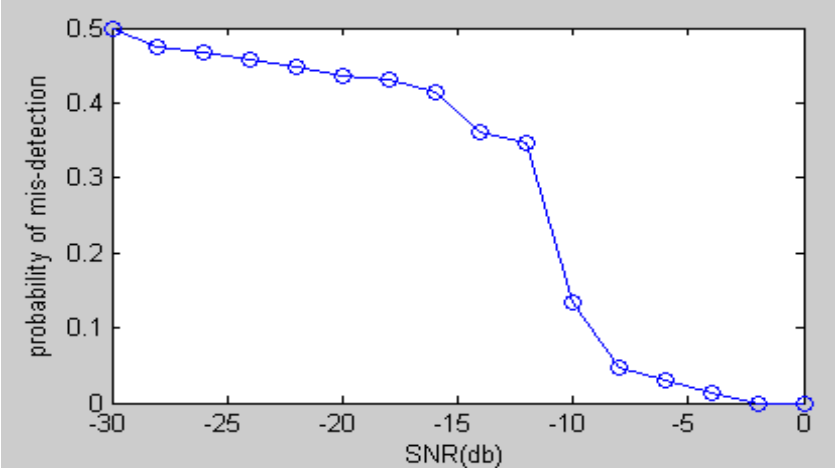

Fig.8. probability of mis-detection Vs SNR for locally optimum detector at ρ = 0.5

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The Detection probability as well as false alarm probability at noise correlation coefficient $\rho = 0.5$ is shown in figure 1 and figure 2 for LO and energy detector. We used BPSK modulation technique for the primary user. As from figure 1, figure 2, the simulation result shows that locally optimum detector has lower false alarm probability and from figure 3 and figure 4 maximum detection probability obtained in LO detector than that of energy detector. For curves shown in figure 1, figure 2 and figure 3, figure 4 rate of increasing detection probability and decreasing false alarm probability higher at beginning. Performance of receiver operating characteristic such as probability of detection and false alarm probability shown in figure 5 and figure 6. Simulated results indicate that at low false alarm probability performance of both the detector is nearly same but as the false alarm probability increases detection by LO detection shows better performance than that of Energy detector. We got more than 1.5db gain in LO detection.
From figure 7 and Figure 8 we can say that with increasing signal to noise ratio probability mis detection decreases more in LO detector than energy detector.

VI. CONCLUSION

In this paper, we considered the LO detection of random signals in additive weakly dependent noise. The test statistic of the LO detector and energy detector for random signal in weakly dependent noise is simulated using receiver operating characteristic. The asymptotic performance of the LO detector was analyzed and compared to that of the Energy detector.

REFERENCES

[1] Farnaz Shayegh, and Fabrice Labeau, "On Signal Detection in the Presence of Weakly correlated Noise over fading channels" IEEE Transactions On Communications, Vol. 62, No. 3, March 2014.
[2] K. Kim, S. Kim, I. Song, and S. Park, "Locally optimum detector for correlated random signals in a weakly dependent noise model," *Signal Process.*, vol. 74, no. 3, pp. 317–322, 1999.
[3] R. Mahapatra and M. Krusheel, "Cyclostationary detection for cognitive radio with multiple receivers," in Proc. 2008 IEEE International Symposium on Wireless Communication systems, pp. 493–497.
[4] F. Digham, M. Alouini, and M. Simon, "On the energy detection of unknown signals over Fading channels ," *IEEE* Tranms. Commun., vol. 55, no. 1, pp. 21–24, 2007.
[5] S. Mishra, D. Cabric, C. Chang, D. Willkomm, B. Van Schewick, S. Wolisz, and B. Brodersen, "A real time cognitive radio test bed for Physical and link layer experiments," in Proc. 2005 IEEE International Symposium on New Frontiers in Dynamic Spectrum Access Network, pp. 562–567.
[6] Mahmood A. Abdulsattar,and Zahir A. Hussein, "Energy detection technique for Spectrum sensing in cognitive Radio: a survey," International Journal of Computer Networks & Communications (IJCNC) Vol.4, No.5, September 2012.
[7] T. Kim, J. Yun, I. Song, and Y. Na, "Comparison of known signal detection schemes under a Weakly dependent noise model," in IEEE Proceedings–Vision, Image and Signal Processing, Vol.141, no. 5. IET, 1994, pp. 303–310.
[8] S. Haykin, D. Thomson, and J. Reed, "Spectrum sensing for cognitive radio," Proc. IEEE, vol. 97, no. 5, pp. 849–877, 2009.
[9] Y. Zeng and Y. Liang, "Eigenvalue-based spectrum sensing algorithms for cognitive radio," IEEE Trans. Commun., vol. 57, no. 6, pp. 1784–1793, 2009.
[10] E. Hossain, V. Bhargava, and I. NetLibrary, *Cognitive Wireless communication* Network .Springer,2007.