Impact Factor (SJIF): 3.632

International Journal of Advance Research in Engineering, Science & Technology

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

Volume 3, Issue 4, April-2016

Improvement in Spectrum Sensing using Eigen value based sensing technique for Digital Primary Signals in Cognitive Radio using MIMO

Vaishali M. Nandotriya[1], Zalak Dobariya[2]

[1]*Electronics & Communication Department, Silver oak Collage of Engineering & Research*
[2]*Electronics & Communication Department, Silver oak Collage of Engineering & Research*

Abstract — In present day communication wireless communication has become the most popular communication. Cognitive radio has emerged as one of the most promising candidate solutions to improve spectrum utilization in next generation cellular networks. The main problem is the interference between the primary signal and secondary signal. We need a technique to deal with the problem of spectrum underutilization, which makes the birth of cognitive radio. Energy detection can be used for spectrum sensing in cognitive radios when no prior knowledge about the primary signals is available. And also observing that when probability of false alarm decreased with the time of probability of detection increased. We propose new sensing methods based on the eigenvalues of the covariance matrix of signals received at the secondary users. In particular, two sensing algorithms are suggested, one is based on the ratio of the maximum eigenvalue to minimum eigenvalue; the other is based on the ratio of the average eigenvalue to minimum eigenvalue.

Keywords- Primary user, Secondary user, Cognitive Radio, Eigen value

I. INTRODUCTION

A cognitive radio (CR) is an intelligent radio that can be programmed and configured dynamically. Such a radio automatically detects available channels in wireless spectrum, then accordingly changes its transmission or reception parameters to allow more concurrent wireless communications in a given spectrum band at one location. This process is a form of dynamic spectrum management.

There is a main problem which is the probability of false alarm. In this project we reduce the probability of false alarm and increase the probability of detection. Spectrum sensing is a fundamental component is a cognitive radio. Cognitive radio has emerged as one of the most promising candidate solutions to improve spectrum utilization in next generation cellular networks.

The problem is the interference between the primary signal and secondary signal. We need a technique to deal with the problem of spectrum underutilization, which makes the birth of cognitive radio. Energy detection can be used for spectrum sensing in cognitive radios when no prior knowledge about the primary signals is available. Cognitive radio is widely expected to be the next Big Bang in wireless communications. To make a decision on whether signal is present, we need to set a threshold.

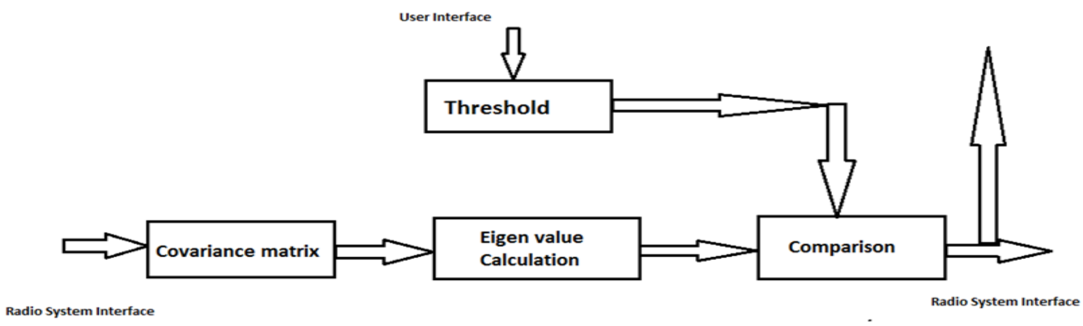

Figure 1. Block Daigram of Eigen Based Spectrum Sensing

In the figure (1) shown there is a block diagram for Eigen based Spectrum Sensing. In the block diagram shown, the signal is converting in the covariance matrix form. In the process of the calculation we used the Eigen value calculation. We have fixed the threshold value for the calculation.

There have been many factors that have led to the development of cognitive radio technology. One of the major drivers has been the steady increase in the requirement for the radio spectrum along with a drive for improved communications and speeds[7]. In addition to this there have been many instances where greater communications flexibility has been required. Along the way, there have been several significant milestones along the road to develop cognitive radio technology.

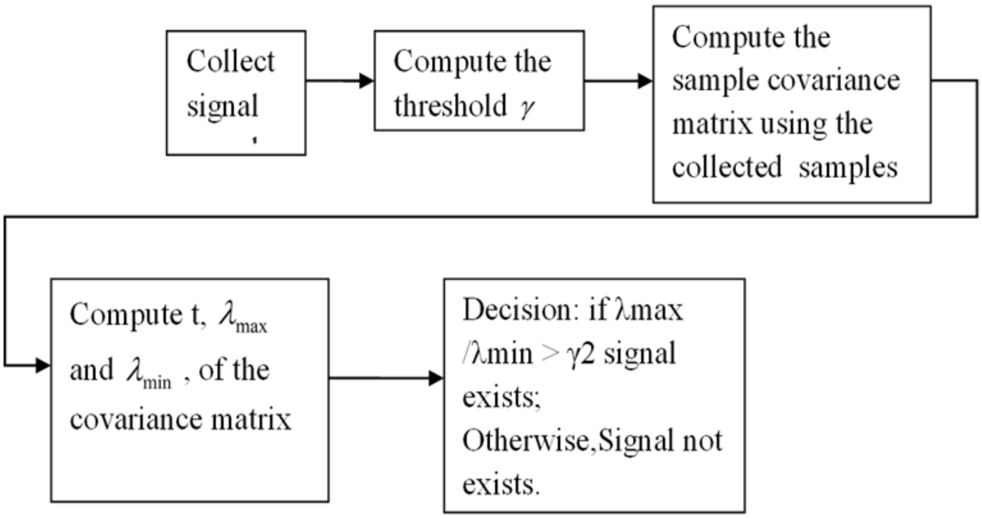

Figure 2. Block Daigram for MME method

The spectrum sensing problem has gained new aspects with cognitive radio and opportunistic spectrum access concepts. It is one of the most challenging issues in cognitive radio systems. In cognitive radio mobile ad hoc networks, secondary users can cooperatively sense the spectrum to detect the presence of primary users. Spectrum sensing, that is, detecting the presence of the primary users in a licensed spectrum, is a fundamental problem for cognitive radio.

II. EIGEN VALUE BASED SPECTRUM SENSING

Spectrum sensing is commonly considered as a binary hypothesis testing problem. Under the H_0 hypothesis, the primary user is absent and the primary user is present under H_1 hypothesis:

$$H_0 : y(n) = w(n) \approx N(0, \sigma_x^2 + \sigma_w^2)$$
$$H_1 : y(n) = s(n) \otimes h(n) + w(n) \approx N(0, \sigma_x^2 + \sigma_w^2)$$

Here, s(n) is the primary user signal, h(n) is the channel impulse response and w(n) is assumed to be additive white Gaussian noise (AWGN).

Two eigen value based algorithms for spectrum sensing, which are described in the following:

***Algorithm 1: Max-Min eigenvalue based sensing (MME)*:**

Statistical covariance matrix can be estimated using the sample covariance matrix, which is obtained by averaging N sample covariance matrices:

$$R_{yy}(N) = \frac{1}{N} \sum_{n=ML-1}^{L-2+N} \hat{y}(n)\hat{y}(n)^{+}$$

Here n indicates the last sample used in the calculation of each covariance estimate. The sample autocorrelations of the received signal which are defined as follows:

$$\gamma_y(l)= \frac{1}{N}\sum_{n=0}^{N} y(n)\, y^*(n-1) \qquad l=0,1,2\ldots ML-1$$

where * denotes complex-conjugation. The sample covariance matrix can then be expressed as

$$R_{yy} = \begin{pmatrix} r_y(0) & r_y(1) & \cdots & r_y(ML-1) \\ r_y(1) & r_y(0) & \ddots & r_y(ML-2) \\ \vdots & \ddots & \ddots & \vdots \\ r_y^*(ML-2) & r_y^*(ML-3) & \vdots & r_y(1) \\ r_y^*(ML-1) & r_y^*(ML-2) & \cdots & r_y(0) \end{pmatrix}$$

Next, the largest and smallest eigenvalues ($\lambda_{max}, \lambda_{min}$)of the sample covariance matrix $R_{yy}(N)$ are computed and the ratio of $\lambda_{max}/\lambda_{min}$ is compared with the threshold γ_1 which is calculated according to the distribution of the noise sample covariance matrix. The threshold value is calculated using desired false alarm probability and as follows:

$$\gamma_1 = \frac{(\sqrt{N}+\sqrt{ML})^2}{(\sqrt{N}-\sqrt{ML})^2} * \left(1+\frac{(\sqrt{N}+\sqrt{ML})^{-2/3}}{(NML)^{1/6}} F_1^{-1}(1-P_{fa})\right)$$

F_1 is the Cumulative Distribution Function (CDF) of the Tracy-Widom distribution of order 1, which was derived using random matrix theorem as:

$$F_1(t) = \exp\left(-\frac{1}{2}\int_1^{\infty}(q(u)+(u-t)q^2(u))du\right)$$

Algorithm 2: Energy with min eigenvalue based sensing(EME)

The sample covariance matrix $R_{yy}(N)$ and the smallest eigenvalue λ_{min} of the sample covariance matrix are calculated in the same way with *Algorithm 1*. The average energy of the received signal is computed like in the traditional energy detector as:

$$T(n) = \frac{1}{MN}\sum_{n=0}^{NM-1}|y(n)|^2$$

The threshold value γ_2 is calculated with the inverse Q-function Q^{-1} using random matrix theorem as follows:

$$\gamma_2 = \left(\sqrt{\frac{1}{MN}}Q^{-1}(P_{fa})+1\right)\frac{N}{(\sqrt{N}-\sqrt{ML})^2}$$

When$(T(N) / \lambda_{min}) > \gamma_2$ the signal is assumed to be present, otherwise it is expected that there is only noise in the band of interest. In the calculation of the threshold values for the two algorithms, *M*, N, L and P_{fa} parameters are only used.

III. RESULT & CONCLUSION

Here is the graph of Probability of Detection vs. Probability of False alarm

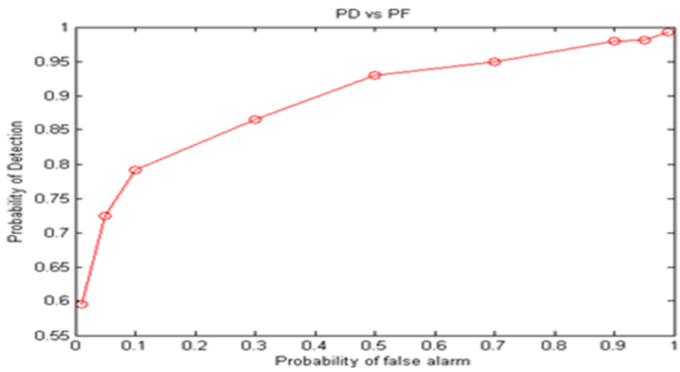

Fig 3. Probability of Detection vs Probability of False alarm

We reduce the Probability of False Alarm with the increase of the Probability of Detection with the used of Eigen value Calculation.

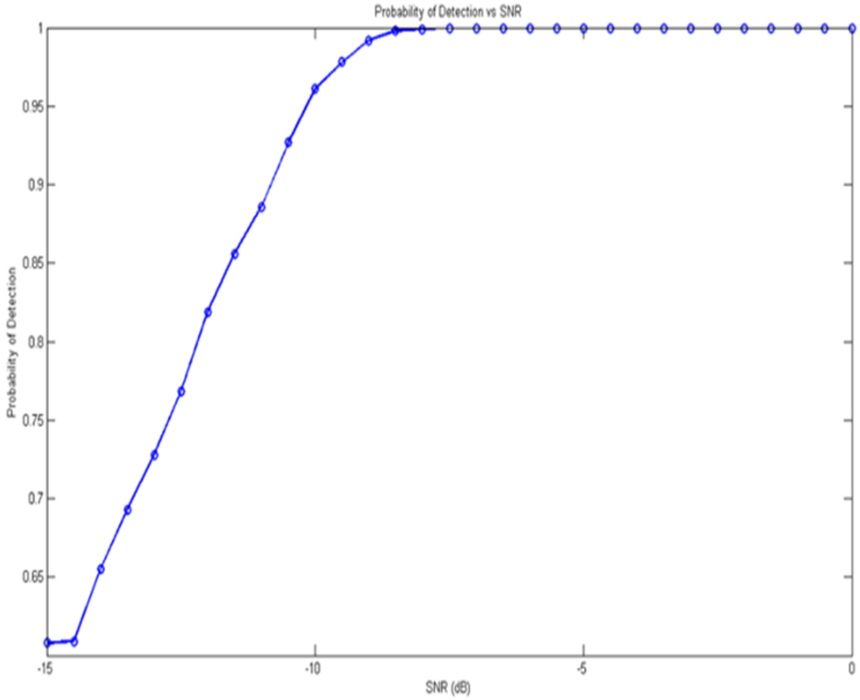

Fig 4. Probability of Detection vs. SNR(dB)

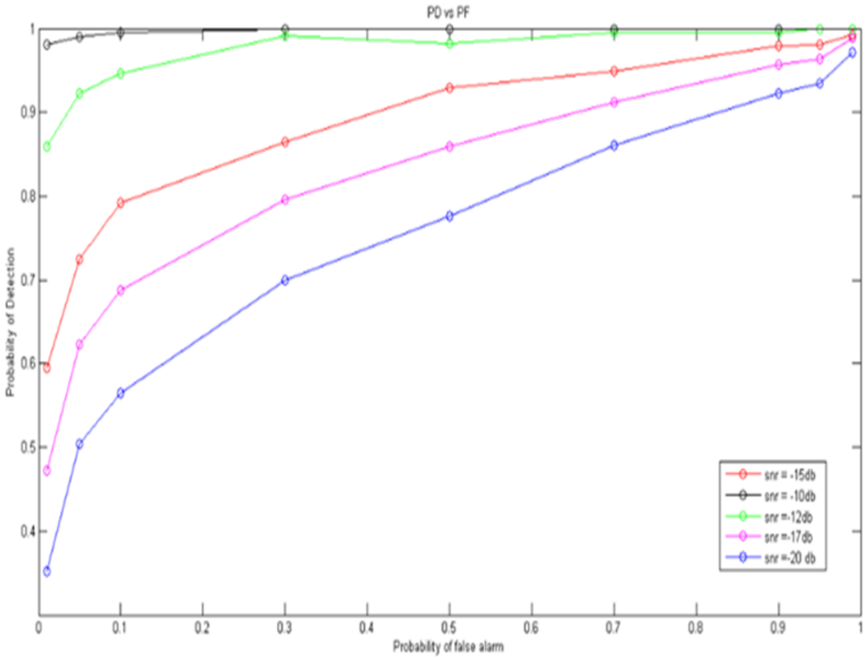

Fig 5. Probability of Detection vs. Probability of False alarm(with different SNR(dB))

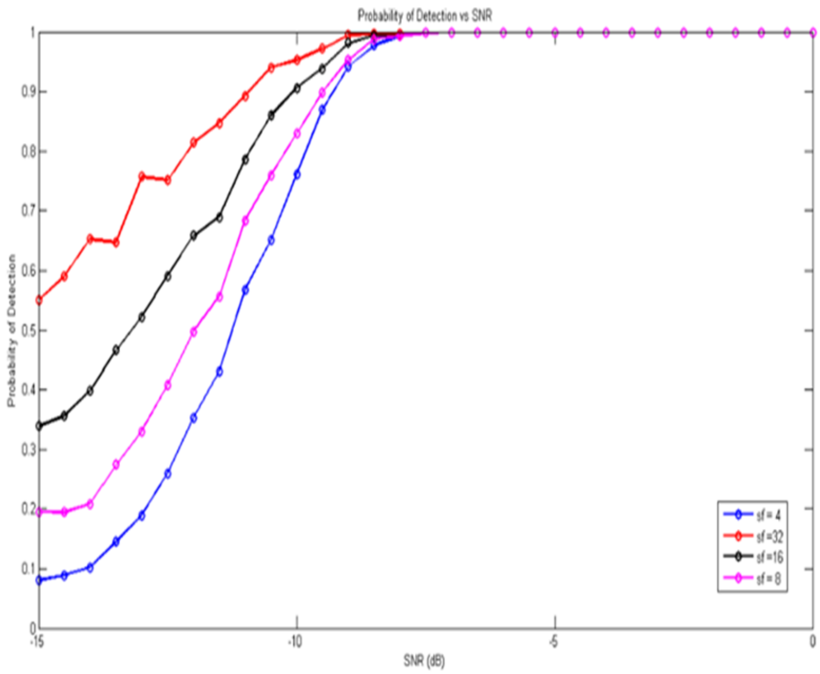

Fig 6. Probability of Detection vs. SNR(with different smoothing factor)

REFERENCES

[1] S. Haykin, "Cognitive radio: Brain-empowered wireless communications, IEEE J. Select. Areas Common, vol. 23, pp. 201–220, Feb. 2005.

[2] Yonghong Zeng, Senior Member, IEEE, and Ying-Chang Liang, Senior Member "Eigenvalue based Spectrum Sensing Algorithms for Cognitive Radio" IEEE Institute for Infocomm Research, A*STAR, Singapore. April 18, 2008.

[3] Hongjian Sun,"Wideband Spectrum Sensing for Cognitive Radio Networks: a survey" Durham University Arumugam Nallanathan, King's College London Cheng-xiang Wang, Heriot-watt university Yunfei chen, University of Warwick.

[4] Raza Umar, Student Member, IEEE, Asrar U. H. Sheikh, Life Fellow, IEEE, and Mohamed Deriche, Senior Member, "Unveiling the Hidden Assumptions of Energy Detector Based Spectrum Sensing for Cognitive Radios" IEEE

[5] Yonghong Zeng*, Ying-Chang Liang, AnhTuan Hoang and Rui Zhang, "A Review on Spectrum Sensing for Cognitive Radio: Challenges and Solutions"

[6] J.Mitola and G.Q.Maguire,"Cognitive radios: making software radios more personal," IEEE Personal Communications, vol. 6, no. 4, pp. 13–18, 1999.

[7] S. Haykin,"Cognitive radio: brain-empowered wireless communications,"IEEE Trans. Communications, vol. 23, no. 2, pp. 201–220, 2005.

[8] D. Cabric, S. M. Mishra, D. Willkomm, R. Brodersen, and A.Wolisz, "A cognitive radio approach for usage of virtual unlicensed spectrum," in 14th IST Mobile and Wireless Communications Summit, June 2005.

[9] FCC, "Facilitating opportunities for flexible, efficient, and reliable spectrum use employing cognitive radio technologies, notice of proposed rule making and order," in FCC 03-322, Dec. 2003.FCC, ET Docket No. 03-222 Notice of proposed rule making and order, Dec. 2003.

[10] Z. L.Chin, F,"OFDM Signal Sensing for Cognitive Radios," Proc. IEEE Symp.
   a. Personal, Indoor and Mobile Radio Communications (PIMRC '08)), pp. 1-5, Sept.
   b. 2008, doi:10.1109/PIMRC. 2008. 4699404.