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SNR-Based Performance Evaluation of Spectrum Sensing in Cognitive Radio System Using Energy Detector

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Abstract—Now a days increase the demand of wireless application.so it's important to manage this spectrum in efficient manner. Cognitive radio is a technique used to determine the spectrum hole. To share this spectrum using cognitive radio between primary user and secondary user (SUs) it requires reliable occupancy detection of spectrum by the (SUs).Cognitive radio is a system used to avoid interference between primary user and secondary user. Cognitive radio system consists of different function such as spectrum decision, spectrum analysis, spectrum management and spectrum sensing. But our main focused on spectrum sensing for SNR evaluation purpose. In this paper we use energy detection method for SNR evaluation purpose.

Keywords—Spectrum holes, spectrum sensing, Energy detection, probability detection (Pd), probability of false alarm

I. INTRODUCTION

Now a day research has been increase in the wireless area. Cognitive radio is a wireless technology used for efficient spectrum utilization purpose. Spectrum opportunities cannot be created commonly. In a widely used spectrum environment it is difficult to unutilized and access to white space spectrum. Cognitive radio system [1] must search the gray and white spectrum to provide a solution to the spectrum issues. Several methods allow cognitive radios to familiarize themselves with an unknown spectrum environment, recognizing specific moderately utilized spectrum bands that present an opportunity to be exploited using learning-enhanced dynamic spectrum access (DSA) techniques. Cognitive radio system consists of different function. That function must be widely used for spectrum utilization purpose. Cognitive radio is a system which we are used to solution for spectrum congestion.FCC: cognitive radio is a system used for dynamic spectrum access purpose.According to a Federal Communications Commission (FCC) it show a typical period survey, the licensed spectrum usage (e.g. particular police dispatch channel in New York State) ranges from 15% to 85% [2]. Cognitive radio changes its transmission and reception parameter according to the environment requirement [3]. When primary user in use and that time secondary user are also present to avoid interference secondary user sense before their interference occurs [4]. Cognitive radio vacate place which is not currently in use is called white space or whole. When spectrum is available it move another spectrum whole as shown in Fig.1 [5]

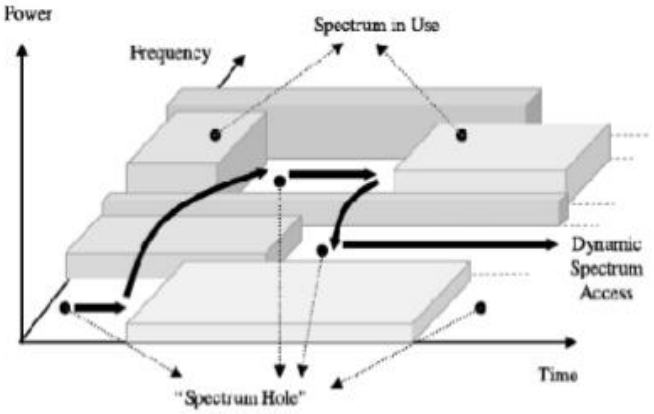

Fig. 1Spectrum Holes

II. RELATED WORK

Cognitive radio system consists of different function such as spectrum decision, spectrum analysis, spectrum management and spectrum sensing. But our main focus on spectrum sensing. When spectrum sensing course in cognitive radio system should consider various factors as shown here [6]. Cognitive radio system to continuously sense the spectrum. It is important that CR system should show the return of primary user to its own spectrum. Controlling for other empty spectrum is necessary. Controlling Type of transmission is important for the cognitive radio to detect the type of transmission being received. It will be necessary to avoid the spurious transmissions and interference made by CR itself. In the case of intelligent wireless systems, cognitive radio is reliable to sense the surroundings spectrum.

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Spectrum sensing is important for collecting various information before a decision is taken. Spectrum sensing involves which bandwidth of spectrum interest, which part of spectrum it should sense & how, any priori information is available about spectrum or not. It consist many steps which help in taking a decision of the presence available spectrum. It involved many steps to gatheringinformation is as shown in the Fig 2.

Fig. 2 Information gathering of spectrum sensing

III. ENERGY DETECTOR

Energy detection method is also used in way to determine the signals of primary user. It detect the signal without prior information of secondary user. Overall observation of energy detector it measures the waveform of received energy signal. It consist of square law device followed by a finite time integrator [7].To limit the noise bandwidth the noise pre filter can be used. At the input noise shroud be band limited, spectrum density should be flat. The threshold value is to be set to compare energy found of the detector. If the threshold is less than the energy detector it indicates the primary user present. The energy is determined by using following equation.

$E = \sum_{n=0}^{N} |X(n)|^2$ (1)

The comparison of energy detector to a threshold ε for determines which hypothesis is to be correct.

$E > \varepsilon \rightarrow H_1$ (2)

$E > \varepsilon \rightarrow H_0$ (3)

The probability of false alarm P_f can be calculated using the hypothesis H_0 as bellow.

$P_f = Q\left(\left(\frac{\varepsilon}{\sigma_n^2} - 1\right)\sqrt{N}\right)$ (4)

Similarly, the probability of detection P_d can be calculated using the hypothesis H_1 as bellow.

$P_d = Q\left\{\left(\frac{\varepsilon}{\sigma_n^2} - (\gamma + 1)\right)\sqrt{\frac{N}{2\gamma+1}}\right\}$ (5)

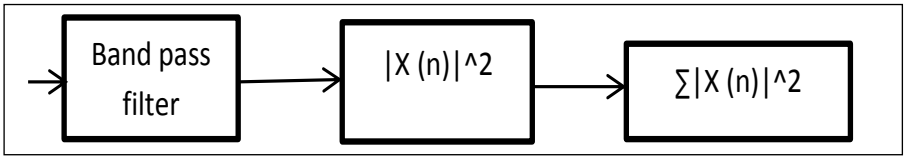

Fig.3 Energy detector

The implementation steps for proposed energy detection method are described below:
Step 1: Take the value of linear SNR in decibels
Step 2: Consider the value of probability of false alarm within certain limit
Step 3: Here we consider the Number of Monte Carlo Simulations between the range kk=1:10000
Step4: Here we consider the AWGN channel noise with mean 0 and variance 1
Step 5: Then take real valued Gaussian Primary User Signal

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Step 6: Received signal at SU
Step7: Calculate the energy of received signal over N samples and test Statistic for the energy detection
Step8: Then take theoretical value of Threshold, refer, Sensing Throughput Trade-off in Cognitive Radio, Y. C. Liang
Step9: Check whether the received energy is greater than threshold, if so, increment Pd (Probability of detection) counter by 1
Step10: Calculate the Probability of detection for theoretical analysis purpose
The comparison result of simulation and theoretical value as shown in fig 4. From this fig. we observe that the energy detector is good in low SNR walls and it is worst in high SNR walls.

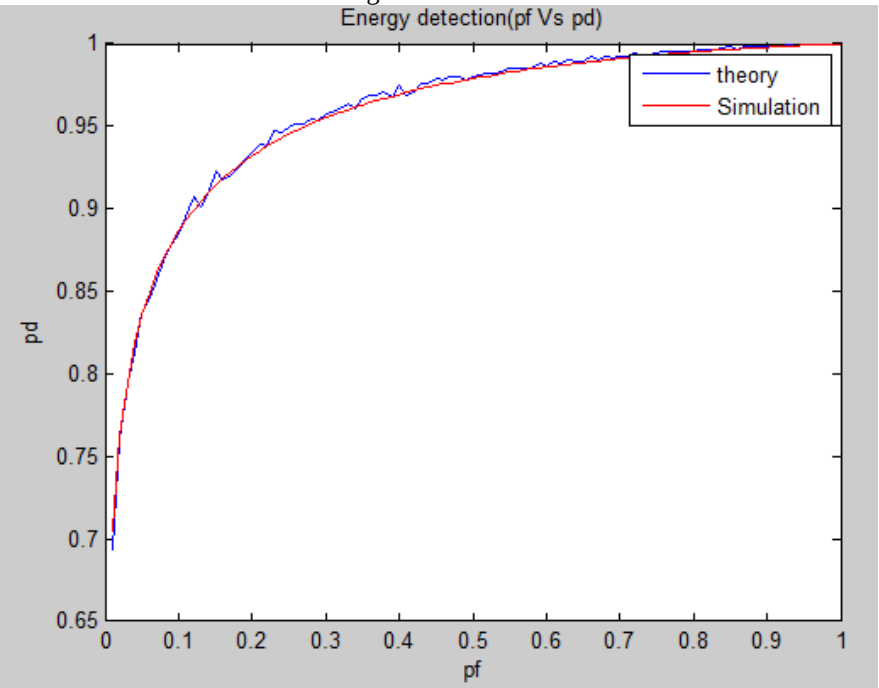

Fig. 4Probability of false alarm vs. probability of detection of energy detector for MPSK primary signal over AWGN channel in low SNR walls

IV. CONCLUSION

From above observation of energy detector it is conclude that
(a)Prior information is not requiring to primary signal.
(b)It gives good performance in low SNR walls.
(c)But it performance is bad in high SNR walls.
Energy detector is an efficient technique for wireless applications due to its high spectral efficiency. From above observation it is conclude that energy detector give good result in low SNR regime. The major drawback of energy detector system is worst in high SNR regime. One can use Approximate Bayesian detector for low and high SNR in proposed method to improve performance.

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