Analysis and Comparision of Different Spectrum Sensing Technique for IEEE 802.11

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ABSTRACT

The electromagnetic spectrum is natural resources. The use of wireless communication grows day by day but spectrum allocation policies is static, it tends to increase the spectrum scarcity problem. COGNITIVE RADIO refers to advance wireless radio which aims to improve the spectrum utilization by identify unused spectrum from environment. Spectrum sensing proposed the key method of cognitive radio which detects the presence of primary user in licensed frequency band to utilize unused spectrum. There are three categories of spectrum sensing techniques; Non-Cooperative System, Cooperative System, Interference Based Sensing. The current work aim on the performance analysis of Non-Cooperative System under low and high SNR, validating the result and applied the technique for IEEE 802.11 (WLAN), IEEE 802.16 (WIMAX). To estimate the threshold chi-square equation has been solve and identify no. of detected signal, signal under AWGN with the help of MATLAB software. It has been observed during analysis that energy rises at high SNR under AWGN and under high SNR no. of detected signal decreases gradually when the no. of sample increases. Under low SNR no of detected signal increases when no. of sample increases gradually.

Keyword: *Cognitive radio, Non-cooperative system, WLAN, WIMAX, AWGN*

1. INTRODUCTION

The demand of wireless communication grows rapidly. Due to limited spectrum allocation policy, raise a problem named spectrum scarcity. Most of the useful spectrum is allocated to licensed users (e.g. mobile carriers, TV broadcasting companies) that do not utilizes allocation spectrum band in all the geographical locations all the time. The licensed users are those users who paid licensing fee to the government agencies like Telecom Regulatory Authority of India (TRAI) and Federal Communications Commission (FCC) in the United States. If this unused spectrum is opened for unlicensed user (e.g. private users, short range networks) then it becomes promising solution to spectrum scarcity problem. Some of the examples are Wi-Fi and Bluetooth operating in unlicensed bands.

The cognitive radio is an emerging technology in wireless communication. Cognitive radio is an advanced technique which reduces the problem of spectrum scarcity in electromagnetic spectrum. Spectrum sensing is one of the method which checks the emptiness of primary user allocated to particular frequency spectrum. There are several methods for spectrum sensing for Non-cooperative and cooperative system. Some of the techniques for spectrum sensing for Non-cooperative system are energy detection, matched filter, cyclostationary feature detection.

In this paper we analyze the performance Non-Cooperative System under low and high SNR , validating the result and applied the technique for IEEE 802.11 (WLAN), IEEE 802.16 (WIMAX).

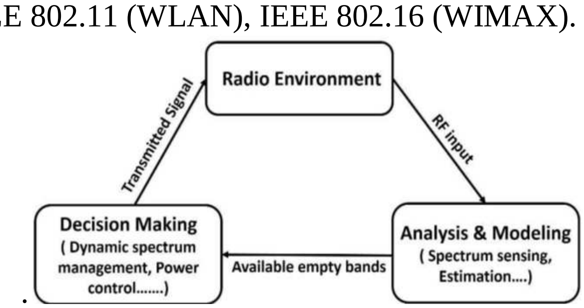


Fig1. Cognitive radio cycle

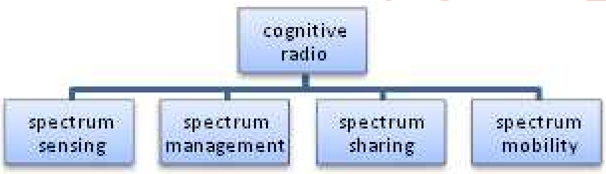
Hence to estimate the threshold chi-square equation has been solve and identify no. of detected signal, signal under AWGN with the help of MATLAB software.

2. THEORETICAL BACKGROUNDS

The demand of wireless communication grows rapidly. Due to limited spectrum allocation policy, raise a problem named spectrum scarcity .To mitigate the problem of spectrum scarcity we use cognitive radio.

2.1 Cognitive Radio:

Cognitive radio is a technology through which unutilized spectrum is detected and if primary user occurs it jump to another unutilized spectrum to avoid the interfering to another primary user or licensed user.



Fig;-2 Functional block diagram of cognitive radio

2.2 Spectrum Sensing:

The main objective of spectrum sensing is to identify the spectrum is available for secondary users or not and it also detect the presence of primary users from licensed band. Simply spectrum sensing is a method which determine whether a given frequency band is being used.

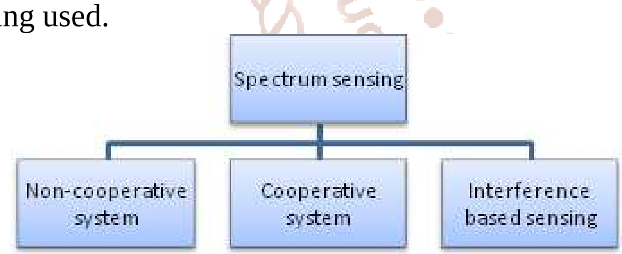


Fig-3 Types of spectrum sensing technique

2.3 Non- cooperative system:

In this system no cooperation is allowed during transmission due to lack of communication between sensing terminal that is known as non-cooperative system. Basically it is divided into three parts: Energy detection, Matched filter detection, Cyclostationary detection

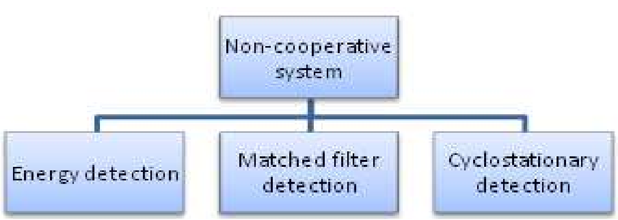


Fig 4- Types of Non-cooperative system

2.3.1 Energy detection:

It is a no cooperative detection technique .It simple detection technique because it does not require prior information about structure of signal. Energy detection is based on the principle that, at the reception, the energy of the signal to be detected is calculated. It estimates the presence of a signal by comparing the energy received with a known threshold λ derived from the statistics of the noise.

2.3.2 Matched filter detection:

Matched filter is a linear filter which used to maximize signal to noise ratio in presence of additive noise. It provides coherent detection. A coherent detector uses the knowledge of the phase of the carrier wave to demodulate the signal.

2.3.3 Cyclostationary detection:

MF detection performances better in low SNR condition. But MF requires prior information about signal structure for licensed user detection. So with limited information about signal structure primary user detection can be possible by using cyclostationary feature detection.

3. PROBLEM FORMULATION:

3.1 Energy detection:

$$\boldsymbol{R(t)} = \begin{cases} \boldsymbol{n(t)} & \boldsymbol{X_0} \\ \boldsymbol{s(t) + n(t)} & \boldsymbol{X_1} \end{cases}$$

$$\boldsymbol{E(t)} = \begin{cases} \boldsymbol{X_0}, & E < \lambda \\ \boldsymbol{X_1}, & E \geq \lambda \end{cases}$$

Where R(t) is receive signal at each instant ‘t’, n(t) is the noise, s(t) is the detected signal which presence in the network, X_0 is the no signal transmitted X_1 is the signal transmitted and E(t) is estimated energy of the received signal.

3.2 Chai-square distribution equation:

$$\boldsymbol{E} \sim \begin{cases} \boldsymbol{N(n\sigma_n^2, 2n\sigma_n^4)} & \boldsymbol{X_0} \\ \boldsymbol{N\left(n(\sigma_n^2 + \sigma_s^2, 2n(\sigma_n^2 + \sigma_s^2)^2)\right)} & \boldsymbol{X_1} \end{cases}$$

Where n is the number of the samples, σ_n^2 is the variance of the noise, σ_s^2 is the variance of the received signal s (t).

$$\boldsymbol{P_f = Q\left(\frac{\lambda - 2t_s w\sigma_n^2}{\sqrt{4t_s w\sigma_n^4}}\right)}$$

Where P_f is the probability of false alarm, t_s is the time symbol or observation time, w is the bandwidth of the spectrum and **λ** is the threshold value which is determined through this equation.

$$\boldsymbol{\lambda = \sqrt{4t_s w\sigma_n^4} Q^{-1}(P_f) + 2t_s w\sigma_n^2}$$

3.2.1 Geometrical model

PARAMETERS	SYMBOL	VALUE
Bandwidth	W	10^5
Signal to noise ratio	SNR	30 &-30
Time symbol	t_s	10^{-2}
No. of sample	N	100 & 200
Variance of the noise		$*10^{-12}$
Variance of the signal		10^{-6}

4. RESULTS

The result obtained as a result of detecting the signal using MATLAB software has been plotted below which has been taken with variable sample size such as 100 and 200 as well as variable energy such as -30 Db and 30 Db

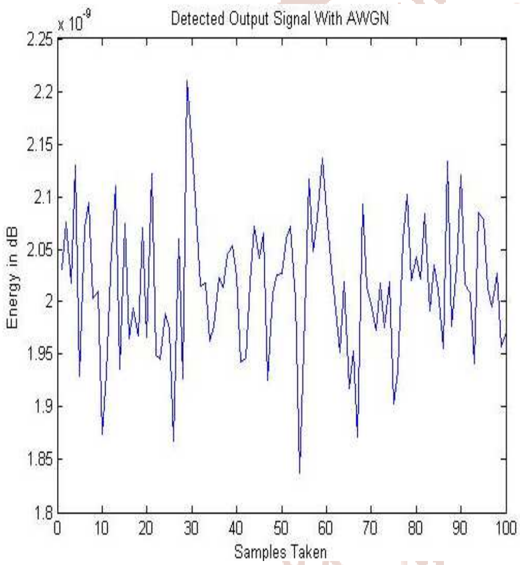


Fig 5 received signal under AWGN

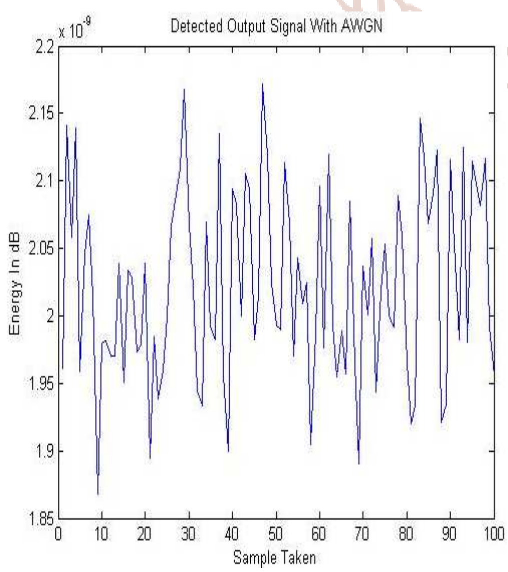


Fig 6 energy at -30 Db at 100 sample

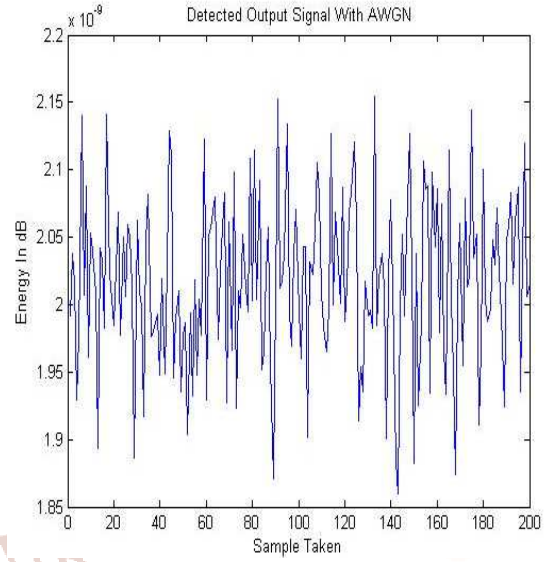


Fig7 energy at 30 db at 200 sample

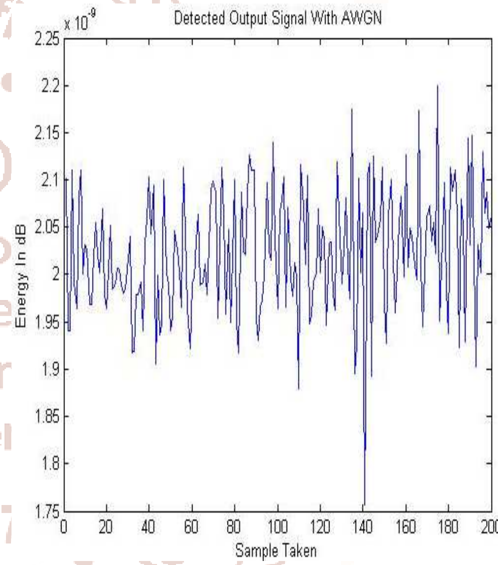


Fig 8 energy at -30 db at 200 sample

The result of energy detector using MATLAB shows no. of detected signal

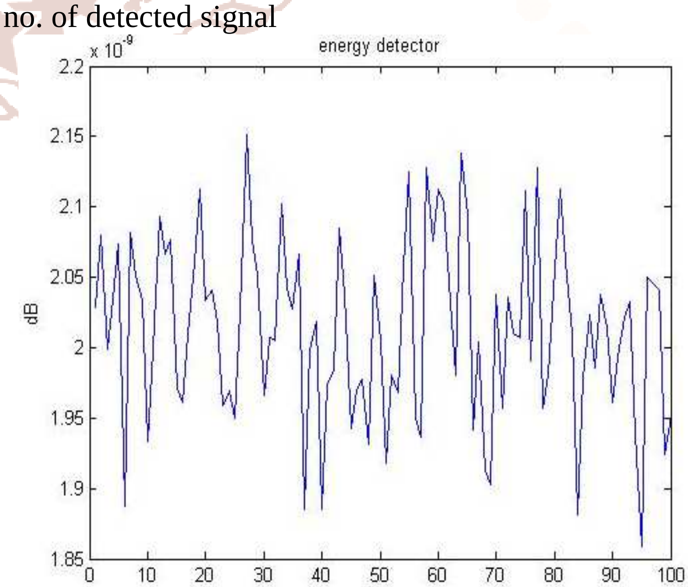


Fig 9 30 dB SNR at 100 sample

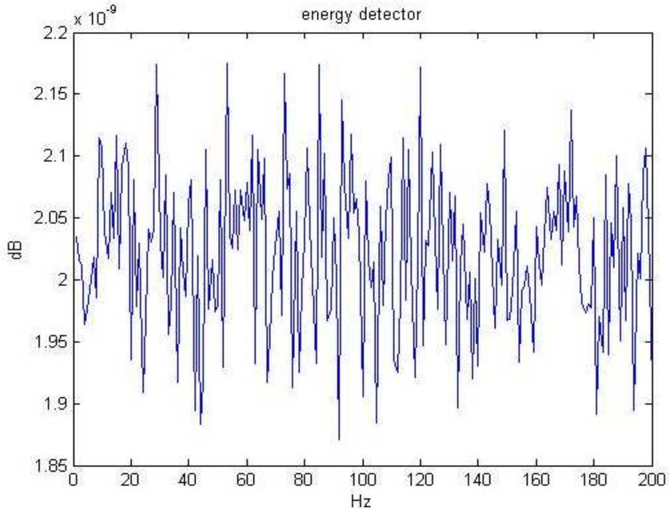


Fig 10 30 dB SNR at 200 sample

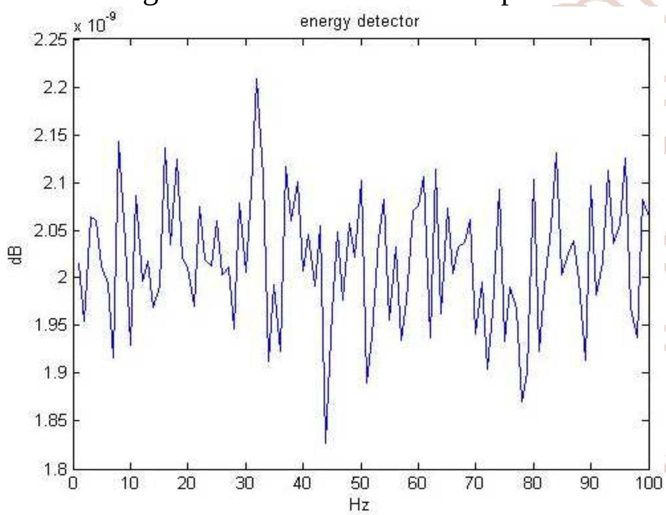


Fig 11 -30 dB SNR at 100 sample

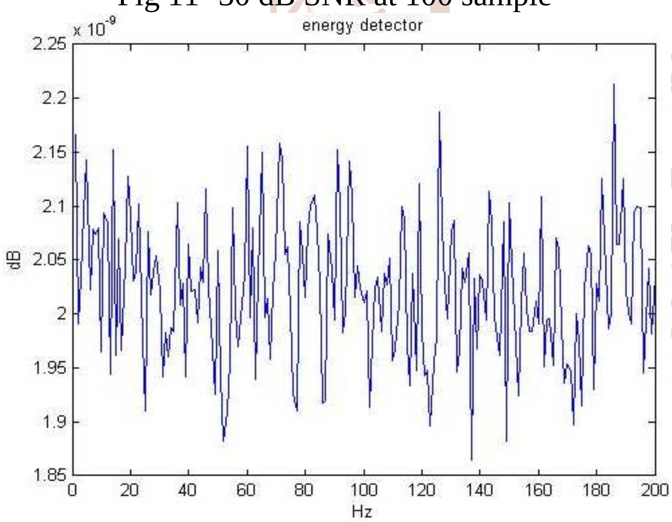


Fig 12: -30 dB SNR at 200 sample

5. CONCLUSIONS

- Different energy signal at different sample at high and low SNR.
- It also show that under high SNR no. of detected signal decreases gradually when the no. of sample is increases, under low SNR no of detected signal increases when no. of sample increases.

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