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Efficient Spectrum Sensing for Cognitive Radio Networks via Joint Optimization of Sensing Threshold and Duration using MATLAB/SIMULINK

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Abstract

Frequency band is valuable in communication media. Different Telecommunication regularity authority have the rights to assign the spectrum to the users and the policy to assign spectrum till date is static frequency allocation policy due to such policies scarcity of the spectrum present. It is required to implement the dynamic frequency allocation techniques (DSS) to improve the spectrum usage. There are different techniques for spectrum sensing like energy detection, matched filter, cyclostationary, compressive, cooperative etc. Every method has its loops and holes, Energy detection method is useful and very simple method for spectrum sensing. In energy detection method output of energy detector compares with predefined threshold valueIn this implementation analysis like different other parameters like ROC, probability of detection (Pd), False alarm probability (FAP), Power spectral density (PSD). The simulation results shows that use of DSS avoids the wastage of bandwidth, probability of false alarm can be attained as well as receiver operating characteristic can be monitored, the simulation results are verified.Index Terms—Cognitive radio, spectrum sensing, Energy detection, Matlab /Simulink simulation

INTRODUCTION

The increasing demand for diverse high quality of-service (QoS) wireless applications, such as Internet browsing, interactive gaming, mobile TV, and video and audio streaming, has put great pressure on the already crowded frequency spectrum. However, recent studies by the Federal Communication Commission have indicated that there is very little usage on a very large range of licensed spectrum in both time and space [1]. Therefore, it is the current static spectrum management, rather than an actual resource scarce, that results in the spectrum scarcity problem. As such, cognitive radio (CR) Provides a promising perspective to improve spectrum utilization by implementing opportunistic spectrum access over the licensed spectrum In a CR system, legacy wireless devices and CR-enabled devices are referred to as primary uses (PUs) and secondary users (SUs), respectively. The SUs sense the spectrum before transmission and opportunistically access the licensed bands based on the spectrum-sensing results. To avoid harmful interference to the PUs, the SUs usually operate in a lower power profile [3].

Cognitive Radio : "An intelligent wireless communication system that is aware of its surrounding environment (i.e., outside world),and uses the methodology of understanding-by-building to learn from the environmentand adapt its internal states to statistical variations in the incoming RF stimuli by makingcorresponding changes in certain operating parameters (e.g., transmit-power, carrier frequency,and modulation strategy) in real-time, with two primary objectives in mind:1)Highly reliable communications whenever and wherever needed; ·2)Efficient utilization of the radio spectrum[7].In cognitive radio terminology, *primary users* defined as the users who have higher priority or authority on the usage of a specific part of the spectrum. On the other hand, *secondary users*, which have lower priority, use this spectrum in such a way that they do not cause interference to primary users. Therefore, secondary users need to have cognitive radio capabilities, such as sensing the spectrum reliably to check whether it is being used by a primary user and to change the radio parameters to exploit the unused part of the spectrum[1].Spectrum sensing techniques has some challenges associated with the sensing for cognitive radio are hardware requirement, hidden primary user problem ,Sensing frequency and duration, detection time opportunistic throughput Section I introduces about cognitive environment. Section II discusses the need of dynamic spectrum access. Section III gives the details about energy detection technique and section IV related to simulation work carried out in MATLAB2013Ra. Section V concludes the paper.

SECTION I

Current wireless networks are characterized by a static spectrum allocation policy, where governmental agencies assign wireless spectrum to license holders on a long-term basis for large geographical regions. Recently, because of the increase in spectrum demand, this policy faces spectrum scarcity in particular spectrum bands. In contrast, a large portion of the assigned spectrum is used sporadically, leading to underutilization of a significant

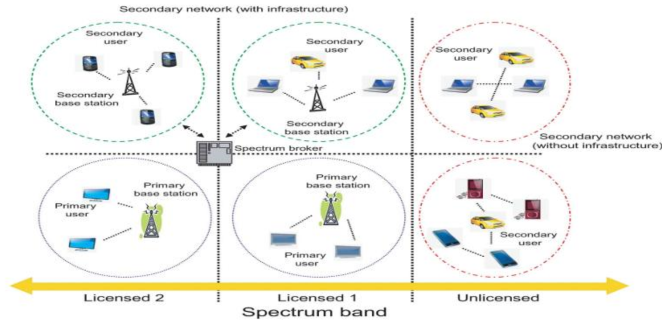

Figure.1. Need of dynamic Spectrum Access

Considering the more flexible and comprehensive use of the spectrum resources, especially when secondary users coexist with primary users, traditional spectrum allocation schemes and spectrum access protocols may no longer be applicable. New spectrum management approaches need to be developed to solve new challenges in research related to cognitive radio, specifically, in spectrum sensing and dynamic spectrum sharing. There are different method for energy detection like cooperative, non cooperative ,compressive and use of different noisy channel ,time domain ,frequency domain, power Allocation and subcarrier assignment, double threshold energy detection method. Xiaoge Huang have proposed, the collaborative sensing among secondary users have, where the techniques for collaborative spectrum sensing to overcome multipath fading and shadowing is investigated. Most of the proposed collaborative methods assume all the collaborative participants experience independent and identically distributed (i.i.d.) fading with the same average SNR [5]

SECTION III

ENERGY DETECTION TECHNIQUE:

Energy detector technique also known as period gram, is the most general way of spectrum sensing because of its low computational and implementation complexities. In addition, it is more generic as receivers do not need any knowledge on the primary users' signal. The signal is detected by comparing the output of the energy detector with a threshold which depends on the noise floor.

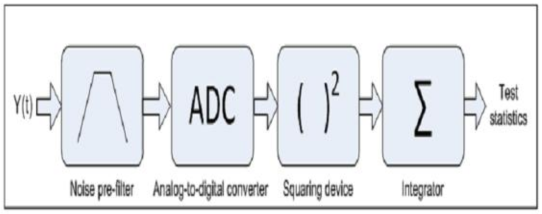

Figure. 2. Block diagram of an energy detector

Let us assume that the received signal has the following simple form

$y(n) = s(n) + w(n)$ (1)

This is general expression of detection of user in spectrum band, where $s(n)$ is the signal power to be detected, $w(n)$ is the additive white Gaussian noise (AWGN) sample, and n is the sample index. Note that $s(n) = 0$ when there is no transmission by primary user. The decision metric for the energy detector can be written as

$$M = \sum_{n=0}^{N} |y(n)|^2, \quad (2)$$

Where N is the size of the observation vector. The decision on the occupancy of a band can be obtained by comparing the decision metric M against a fixed threshold λ_E. This is equivalent to distinguishing between the following two hypotheses:

H0 : $y(n) = w(n)$, (primary user absent) (3)

H^1 : $y(n) = s(n) + w(n)$ (primary user absent) .(4)

P_D& P_F can be formulated as

$P_D = \Pr(M > \lambda_E|H1)$. (5)

$P_F = \Pr(M > \lambda_E|H0)$. (6)

$$P_F = 1 - \Gamma\left(L_f L_t, \frac{\lambda_E}{\sigma_w^2}\right),$$
$$P_D = 1 - \Gamma\left(L_f L_t, \frac{\lambda_E}{\sigma_w^2 + \sigma_s^2}\right)$$

Receiver operating characteristic (ROC) curves can be used. ROC curves shows the relationship between the sensitivity (probability of detection) and specificity (false alarm rate) of a sensing method for a variety of different thresholds, thus allowing the determination of an optimal threshold.[2]

SECTION IV
RESULTS AND DISCUSSION:

Detection of channel ether primary user present or absent:

In a simulation result I take five channel 0 to 1Khz ,1khz to 2khz ,2khz to 3khz ,3khz to 4khz ,4khz to 5khz and plot a graph of B.W against PSD.

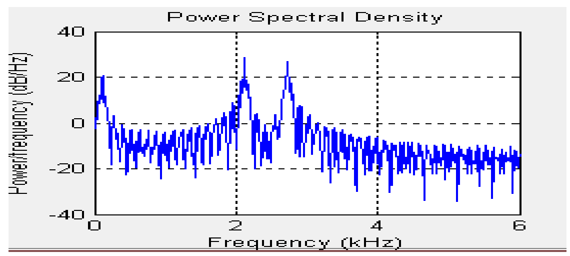

Figure.3. Simulation result of Empty slot detection channel

In above simulation result shows that after detection of channel at 4th and 5th channel, primary users are absent.

Assignment of secondary user at 4th and 5th channel:

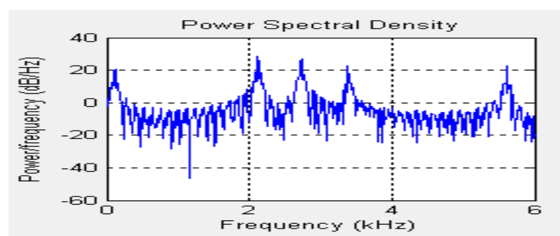

Figure. 4. Simulation result of assignment of secondary user

The simulation result shows at 4th and 5th channel secondary user can use channel when primary does not want to use channel but when primary user want to use channel then secondary user give control to primary immediacy. In addition to this simulation results obtained and analyzed for ROC, MDP,FAP, optimization of energy detection to maximize secondary user market

CONCLUSION

The spectrum sensing algorithm using energy detection technique is simple and easy to implement.. It is observed it improves the scarcity of spectrum. The aggregate throughput , joint optimization sensing threshold and total error rate are calculated by Simulation work carried out in MATLAB R2013a., thus therefore we can maximizes the secondary access market by using energy detection method all.

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