A Review Analysis of Spectrum Sensing Enhanced Energy Detection Technique

Priya Upadhyay[1], Aparna Singh Kushwah[2]

[1]PG Scholar, priyaupadhyay180@gmail.com, UITRGPV, Bhopal(M.P.)
[2]Associate Professor, UITRGPV, Bhopal(M.P.)

Abstract: Spectrum sensing is the basic and essential mechanisms of Cognitive Radio (CR) to find the unused spectrum. In this presents an overview of CR architecture, discusses the characteristics and benefits of a CR. Energy detection based spectrum sensing has been proposed and used widely because it doesn't require transmitted signal properties, channel information, or even the type of modulation. In this work, we investigate a dynamic selection of this threshold by measuring the power of noise present in the received signal using a different technique. In this, a analysis of energy detector over Additive White Gaussian Noise (AWGN), different fading channels for spectrum sensing methodologies in cognitive radio is presented. Theoretical analysis of time domain energy detection and threshold setting is investigated. Cooperative spectrum sensing and a multiple antenna processing based energy detector receptions are also discussed.

Keyword: Spectrum Sensing, Energy Detection, Autocorrelation, Matched Filter, Dynamic Threshold, Software Defined Radio, Probability of Detection

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INTRODUCTION

The dramatic growth in the number of wireless devices alongside the static management of the radio spectrum has created a shortage of available radio spectrum. Over 50 billion wireless devices will be connected by 2020, all of which are likely going to demand access to the Internet. The static management of the radio spectrum is no longer efficient enough to grant access to all these devices. With this allocation, some portions of the radio spectrum are heavily used while some others are not or rarely used. Not sharing the radio spectrum among users can result in the creation of unwanted denial of service events. The scarcity of the radio spectrum is thus one of the most urgent issues at the forefront of future network research that has yet to be addressed. One solution to these and other challenges is to use cognitive radio technology, which has undergone extensive investigation by the research community for almost two decades. Cognitive radio technology allows wireless devices to sense the radio spectrum, decide about the state of the frequency channels, and reconfigure their communication parameters to meet quality-of-service requirements while minimizing their energy consumption. These devices can use unlicensed bands as well as licensed bands when their licensed primary users are not active, preventing adverse interference. Over the last decade, a number of sensing techniques have been proposed which can be classified into two categories: narrowband and wideband. Narrowband sensing analyzes one frequency channel at a time while wideband sensing analyzes a number of frequencies at a time.

In the latter, the spectrum is usually divided into multiple sub-bands and then they are sensed, either sequentially or simultaneously, using the narrowband sensing techniques. Sequential-sensing approaches are ineffective because they require longer times and higher energy due to the use of high-rate analog-to-digital converters (ADC), which is both costly and impractical for timely communications. Simultaneous sensing schemes require a large number of sensors and joint synchronized function, increasing the complexity of a given implementation. A way forward is to decrease the high number of samples acquired using compressive sensing. A number of spectrum sensing projects have shown that most frequency channels of the wideband spectrum are used scarcely or not at all. Hence, the wideband spectrum signals can be regarded as sparse signals, a characteristic that has motivated researchers to investigate the use of sub-Nyquist, or compressive sensing, to speed up the process of the wideband spectrum sensing.

Compressive sensing recovers the original sparse signal from only a few measurements. It involves three main processes: sparse representation, coding with the sensing matrix/measurement, and decoding, also called sparse recovery. To apply compressive sensing, signals are required to be sparse in a given domain and the sensing matrix has to satisfy the restrict isometry property (RIP), or it must have a small mutual incoherence to guarantee the exact recovery of the original sparse signal. The optimal number of measurements depends on the sparsity level of the wideband signal, the measurement matrix, and the recovery techniques being used . Some authors have investigated how to estimate the sparsity level of the wideband signal and then adapt the number of required measurements. Other authors have proposed blind compressive sensing techniques for wideband spectrum sensing, which do not require any prior knowledge of the sparsity level of the wideband signal.

Several survey papers that provide an overview of the wideband spectrum sensing and compressive sensing. Technological advancement of wireless communication in this century brings a variety of wireless products/devices that can be used for a wide range of application. Devices in wireless environments operate on specified licensed spectrum. This operational frequency range should be designed, allocated and properly administrated by governmental institution such as ETA of Ethiopia, FCC of USA. The assigned frequency range can be used in cellular network, FM radio, TV broadcasting service etc. Study at FCC shows that the spectrum usage is highest specifically in cellular network (GSM), TV bands, fixed radio system and FM radio channel. But significant amount of the spectrum remains underutilized. It also shows that the spectrum usage in the band below 3 GHz has utilization efficiencies of 15% to 85% [4,5]. As new service and wireless application are continuously added the system channel will be fully occupied and consequently it creates congestion and channel scarcity. To mitigate this problem, I. Mitola proposed the concept of cognitive radio system in his doctoral dissertation. [6]. Cognitive radio can be defined as a radio system that can adaptively and dynamically allow user(s) to use the spectrum in the opportunistic way [5-8].

LITERATURE REVIEW

Mohamed Amjad Hussain et al. (1) "Enhancing the spectrum sensing performance of cluster-based cooperative cognitive radio networks through multiple reporting channels of any sort" to achieve high PU signal detection accuracy in cluster-based CCRNs It depends on all the sensing in any suitable spectrum and the minimum delay in any reporting time. Here in this paper, we propose a sequential multiple reporting channel for any cluster-based CCRN in order to gain by better sensing by using the reporting time slots of SU correctly. However, the proposed approach minimizes the delay in reporting time of CH. The approach we propose here has increased the sensing gain of SU by using the reporting framework of SU. With respect to the detection gain from any PU signal, it can be ascertained from all the simulation results that the proposed approach has The detection probability for any given CH and FC may be 12% and 15% better than the non-sequential conventional approach, respectively. Also, our proposed and done sequential all-in-all-multiple reporting channel approach for any CCRN of all types of cluster-based sensing reports transmission to the FC as compared to the traditional approach of using parallel multiple reporting channels. Delay in reporting time of CH is minimized. Finally, we show in the simulations that the sequential over multiple reporting channel approach we propose should be more applicable to wireless networking to overcome any spectrum constraint issues. In future research, we can use the approach we proposed for many types of PU signal environments in combination with all kinds of machine learning concepts [1].

Sai Sunil et al. (2) "Peak Detection Based Energy Detection in a New Spectrum Under the Rayleigh Fading Noise Environment" refers to a scarce resource in any spectrum and is designed to be used by owners only for tasks in the spectrum. has gone. The idea of a new type of cognitive radio of all kinds has been established to reprocess any spectrum in an unlicensed manner that is licensed. This method is most commonly used. Which is a full spectrum sensing detection of all kinds as it does not require any previous data on the variation of any significant user signal. In this step, we base it on peak detection that spectrum sensing can improve the signal strength. This method tells us that the power to sense the signal can be reduced in any peak detection process. Due to which the sensing time of any spectrum is reduced. Any subsequent research results illustrate that the proposed techniques can provide higher efficiency than state-of-the-art techniques [2].

K VenkataVar Prasad et al. (3) "For any local sensing in intelligent network any energy detection approach is used. Here's a demonstration of the work being done from the blind detection frame" The framework has been successfully designed and represented. Here any ROC curves can be plotted between the detection probability and the false alarm probability. The SNR when detection probability is found to be different depending on all types of false alarm probability and different types of time bandwidth factors. All types of SNRs can affect the detection probability. When any SNR is increased, the probability of detection is increased here. Sometimes a result demonstrates the ability of a proposed identified structure to operate in a low-noise environment. From all the results here it can be clearly predicted that the probability of detection here will be as high as 1.0 even for a single type of SNR of −18 dB. Similarly, error detection for any technique may also exhibit superior performance, with very little error visible for an SNR of −12 dB. This capability is proposed for any cognitive radio network [3] or their suitability for using blind energy detectors is emphasized.

Peng Fang et al (4) proposed "a kind of rapid coarse-grained blind wideband spectrum sensing method for all types of cognitive radio networks" in this paper, based on all types of CCS to occur from all wideband signals A spectral analysis method was proposed. Unlike other types of methods, the main features of the proposed method are that no sparse constraints and multi-band mode constraints are found in it. All relevant simulation results show that this method can provide such acceptable PSD estimates over a period of 800 MHz when any resolution bandwidth (RBW) is 800/(64 × 3) MHz, where the CSR C is 64, the compression ratio is 0.5, and the crop factor is found to be 3. In comparison with the Nyquist rate method, which requires the 800 MSPS (mega-samples per second) found in the sampling rate of an ADC, the method we propose requires only 12.5 MSPS of the sampling rate of the ADC. need is necessary. One thing to note, however, is the cost of multiple branch circuit ADCs requiring this in all kinds of amounts. This type of hardware performance in wideband spectrum sensing can be significantly reduced. When the error is found to be within an acceptable range for any spectrum detection, the observation time is controlled between 32 µs and 80 µs. Of course, this type of method has been shown to have some drawbacks as well. Firstly here, in terms of accuracy, only coarse-grained spectrum analysis can be provided in this method. The closer the bin occurs in any type of central frequency, the smaller the estimated mean square errors of the PSD. Here it is also concluded that as long as the size of any new observation samples or the covariance estimator or of any type (block -Toplitz matrix), it should be constant in the interval with confidence. Then, one type of prime factor affecting any estimated mean square error can be determined by the compression ratio. Also, the effect of observation time on all types of error can be greatly reduced. It is here that the findings provided the basis for rapid coarse-grained spectrum analysis [4].

Han Lee et al. (5) "Signal detection based on the sub-band energy ratio in the power-spectrum" proposed in this paper, the statistical characteristics resulting from the sub-band energy ratio in the power-spectrum for all signal absence and signal presence cases. A type of systematic investigation is offered. The statistical characteristics of all types of PSERs provide a theoretical basis for the use of PSERs found in signal detection. All these results demonstrate that the PSER followed the beta and doubly non-central beta distributions for the absence and presence of the signal, respectively. According to the statistical characteristics of all these PSERs, a signal detection method based on the PSER could be established. It was found here that the detection performance of all methods was found to be lower than LSED and generally better than TDED. However, the robustness of the PSER detection performance under noise uncertainty was found to be the best of the three methods [5].

G. Dinesh et al (6) "Revised Spider Monkey Adaptation - An Advanced Type of Optimization of Spectrum Sharing in Cognitive Radio Networks" also have to face. One of the major problems of all kinds in this area is the allocation of spectrum effectively. Thus, to improve the scheduling of any spectrum, all spectrum sensing technology called MSMO has been proposed which, in turn, can increase the EE of all available spectrum. It provides a one-of-a-kind global solution and can scale to any number of functional requirements. All types of spectrum scheduling can be done effectively using a modified RR, where the packet flow occurs as a packet queue in the interface controller. Performance metrics such as handoff, false alarm probability, throughput and success probability have been evaluated. The results here suggest that the proposed system can perform well compared to other existing methods [6].

P Ramakrishnan et al. (7) "A Comprehensive Survey on Effective Types of Spectrum Sensing in 5G Wireless Networks Through Networks Found in Cognitive Radios" Identification of the challenges and issues encountered in all existing compressed spectrum sensing approaches in any cognitive radio A systematic survey has been presented for this research work to be done. Network. All types of traditional spectrum sensing process and the difficulties associated with it are analysed, research based on any compressive based on three factors namely sparsity-based model, all acquisition-based model and reconstruction-based all model. Spectrum sensing approach is referred to. Different types of research work can be analyzed in each given section and all types of merits and demerits are observed. On observation the issues in compressive spectrum sensing can be summarized. Further advances in this type of research could be achieved by developing a kind of efficient spectrum sensing and reconstruction algorithms using hybrid models to achieve lower system complexity as well as better performance [7].

Mounil R Vyas et al. (8) In this paper given "Artificial Neural Network Based Hybrid Spectrum Sensing Scheme for Cognitive Radio", a kind of novel hybrid spectrum sensing scheme is proposed. Here the performance is evaluated on the basis of various radio technologies using experimental test bed setup. The obtained results show that the proposed scheme outperforms the classical energy detection method and other advanced energy detection methods used in all the considered radio technologies. One type of aspect can be done in the form of reducing the training time required for future work, the other being the inclusion of all kinds of other relevant features to achieve accuracy for high performance. can be thought of. Of course, the higher the number of all features, the higher the computational complexity can be, thus the two aspects are not obtained simultaneously [8].

Mohammad A Izzat et al. (9) In this paper given "Enhancing the Energy Detection Performance Using RLS and Wavelet De-noising Filters", a new type of energy detection technique resulting from any spectrum sensing is introduced. The proposed technique is based on the use of a filter such as de-noising in the recursive list of squares (RLS), filters from 1-D and 2-D wavelets. The purpose of this type of technique is to increase the SNR gain, decrease in noise variance and estimate any detection threshold. All the resulting ROC curves are clearly visible. It is proposed here that the performance of the detectors can be improved from conventional detector performance. In addition, the system throughput is greatly increased by applying a type of D noise filter for a fixed sensing time. The maximum noise effect can be reduced and the highest throughput is provided [9].

AshishRanjan et al. (10) This paper entitled "Design and analysis of spectrum sensing in cognitive radio based on energy probes" describes the performance of a type of energy detector for primary signal detection by BPSK, QPSK and QAM. successfully presented and analyzed. The theoretical background of the detection and probability of a false alarm occurring in the sensing node on the noise channel of all types of additive White Gaussian can be studied. The given result shows the threshold dependence of a single user energy detector. As the SNR is increased, the detection probability can be increased by using a variety of modulation techniques on the fading and non-fading channels as well as improving the observed performance. At the same time, as the length of the signal increases, so does the detection probability performance. Among such modulation techniques, QAM has been reported as the best technique for spectrum sensing [10].

METHODOLOGY

Energy detection computes the energy of the samples and compares it to a threshold. If the energy is higher than this threshold, the primary user signal is considered present; otherwise, the primary user is considered absent.

Energy detection is the most widely used method since it has low complexity and it does not require prior information about of the primary signals. In the energy detection process, the spectrum occupancy decision is based only on the threshold obtained depending on the noise. The threshold is compared with the perceived energy, and it is decided whether the primary user is present or not. It aims essentially to decide between two states: primary user signal is absent, denoted by H0 , or primary user signal is present, denoted by H1 . The decision of energy detector is the test of the following hypothesis:

$$H0 : Y(n) = W(n), \text{:Primary user absent}$$

$$H1 : Y(n) = S(n) + W(n), \text{:Primary user present} \quad (1)$$

where Y (n) is the signal received by the secondary user, S(n) is the primary user's transmitted signal, and W(n) is the additive white Gaussian noise (AWGN) with zero mean.

31 Multi-Bit Compressive Sensing

Compressive wideband spectrum sensing has recently been the subject of many research studies . The application of compressive sensing in this context is made possible because most of the frequency channels are free, which makes a wideband signal sparse in the frequency domain. Compressive sensing is defined as a paradigm that recovers the sparse signal from a few measurements. The foundations upon which this paradigm rests are the sparsity and incoherence. As shown in Figure , compressive sensing involves three main processes: sparse representation, measurement, and sparse recovery. The sparse representation consists in projecting the signal on a suitable basis to make the signal sparse because compressive sensing applies only to sparse signals. Examples of sparse representation techniques include fast Fourier transform (FFT), discrete Fourier transform (DFT), and discrete cosine transform (DCT). The measurement process takes only a few measurements from the sparse signal by multiplying this signal by a measurement matrix, recovering the original sparse signal. In the following discussion, we describe the mathematical model of each process.

Figure 1. Block diagram of compressive sensing

CONCLUSION

In this we review and analysis of the CRs technology was presented. Energy Signal Detection is introduced as a figure of merit on which to base quantitative assessment of a radiometer's design including its calibration architecture and algorithm. The problem of the spectrum detection schemes was formulated which include Energy detection in every domain. Energy detection has been adopted as an alternative spectrum sensing method for CRs due to its simple circuit in the practical implementation and no information requires about the signal needed to detect.

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