Energy Detection For Spectrum Sensing In Cognitive Radio

Spectrum Sensing Techniques and ApplicationsSpectrum Sensing for Cognitive RadioEnergy Detection for Spectrum Sensing in Cognitive RadioSpectrum Sensing in Cognitive Radio NetworksSpectrum Sensing in Cognitive Radio NetworksRobust and Secure Spectrum Sensing in Cognitive Radio NetworksCooperative Spectrum Sensing Based on 1-bit Quantization in Cognitive Radio NetworksSpectrum sensing techniques in cognitive radioPerformance of Cooperative Spectrum Sensing in Cognitive Radio NetworksSpectrum Sensing in Cognitive RadioCooperative Spectrum Sensing and Resource Allocation Strategies in Cognitive Radio NetworksImplementation of Spectrum Sensing Techniques for Cognitive Radio SystemsSpectrum Sensing in Cognitive Radio NetworksContext Augmented Spectrum Sensing in Cognitive Radio NetworksEnergy Detection Based Spectrum Sensing in Cognitive RadioSpectrum Sensing for Wireless Broadcast Communication SystemsSpectrum Sensing in Cognitive RadioTowards Versatile and Robust Spectrum Sensing in Cognitive RadioSpectrum Sensing, Spectrum Monitoring, and Security in Cognitive RadiosSpectrum Sensing Techniques: Comparative Analysis Marcelo Sampaio de Alencar Kamal M. Captain Saman Atapattu Waleed Ejaz Simin Bokharaiee Najafee Changlong Chen Waleed Alhammami Joydeep Dutta Chilakala Sudhamani Subhashiri G. Mohapatra Xavier Fernando Nazar Mortada Radhi Sepideh Zarrin Nada Gohider Pranav Patel Andreas Bollig Hanwen Cao Erfan Soltanmohammadi Atti Ur Rehman Spectrum Sensing Techniques and Applications Spectrum Sensing for Cognitive Radio Energy Detection for Spectrum Sensing in Cognitive Radio Spectrum Sensing in Cognitive Radio Networks Spectrum Sensing in Cognitive Radio Networks Robust and Secure Spectrum Sensing in Cognitive Radio Networks Cooperative Spectrum Sensing Based on 1-bit Quantization in Cognitive Radio Networks Spectrum sensing techniques in cognitive radio Performance of Cooperative Spectrum Sensing in Cognitive Radio Networks Spectrum Sensing in Cognitive Radio Cooperative Spectrum Sensing and Resource Allocation Strategies in Cognitive Radio Networks Implementation of Spectrum Sensing Techniques for Cognitive Radio Systems Spectrum Sensing in Cognitive Radio Networks Context Augmented Spectrum Sensing in Cognitive Radio Networks Energy Detection Based Spectrum Sensing in Cognitive Radio Spectrum Sensing for Wireless Broadcast Communication Systems Spectrum Sensing in Cognitive Radio Towards Versatile and Robust Spectrum Sensing in Cognitive Radio Spectrum Sensing, Spectrum Monitoring, and Security in Cognitive Radios Spectrum Sensing Techniques:

Comparative Analysis *Marcelo Sampaio de Alencar Kamal M. Captain Saman Atapattu Waleed Ejaz Simin Bokharaiee Najafee Changlong Chen Waleed Alhammami Joydeep Dutta Chilakala Sudhamani Subhashiri G. Mohapatra Xavier Fernando Nazar Mortada Radhi Sepideh Zarrin Nada Gohider Pranav Patel Andreas Bollig Hanwen Cao Erfan Soltanmohammadi Atti Ur Rehman*

spectrum sensing deals with several subjects that range from statistical and probability theory to radio propagation and signal processing with cognitive radio playing an important role to the evolution and dissemination of new applications in the area the objective of this book is to connect the basic statistical formulation the fundamental concepts from signal detection and spectrum sensing cognitive radio and dynamic spectrum access leading to an interesting robust and illustrative content with recent practical applications of cognitive radio and spectrum sensing

this comprehensive reference text discusses concepts of cognitive radio and the advances in the field of spectrum sensing this text discusses the concept of cognitive radio for next generation wireless communication and a very critical aspect of cognitive radio that is spectrum sensing in detail it covers important topics including narrowband spectrum sensing wideband spectrum sensing cooperative spectrum sensing system and channel models detection algorithms approximation of decision statistics and theoretical analysis of detection algorithms in detail separate chapters are dedicated to discussing the analysis and use of detection algorithms for narrowband spectrum sensing wideband spectrum sensing and cooperative wideband spectrum sensing aimed at graduate students and academic researchers in the fields of electrical engineering and electronics and communication engineering this text discusses concepts of cognitive radio and research in spectrum sensing presents mathematical analysis of algorithms considering practical environment explains novel wideband spectrum sensing algorithms with detailed analysis provides mathematical derivations to help readers discusses basic spectrum sensing algorithms from narrowband spectrum sensing to the more advanced wideband spectrum sensing

this springer brief focuses on the current state of the art research on spectrum sensing by using energy detection a low complexity and low cost technique it includes a comprehensive summary of recent research fundamental theories possible architectures useful performance measurements of energy detection and applications of energy detection concise practical chapters explore conventional energy detectors alternative forms of energy detectors performance measurements diversity techniques and cooperative networks the careful analysis enables reader to identify the most efficient techniques for improving energy detection performance energy detection for spectrum sensing in cognitive radio is a valuable tool for researchers and practitioners interested in spectrum sensing and cognitive radio networks advanced level students studying

wireless communication will also benefit from this brief

recent research shows that 70 of the available spectrum is not utilized efficiently the bandwidth gets expensive owing to shortage of frequencies for efficient utilization of spectrum we need to sniff the spectrum to determine whether it is used by primary user or not the term cognitive radio refers to the adoption of radio parameters using the sensed information of the spectrum there are three major categories of spectrum sensing techniques transmitter detection receiver detection and interference temperature detection this book presents a survey of techniques suggested in the literature for spectrum sensing with a performance analysis of transmitter based detection techniques a fuzzy logic based technique for primary user detection has also been proposed in comparison with transmitter detection techniques purposed technique provides good results under low snr values

given the ever growing demand for radio spectrum cognitive radio has recently emerged as an attractive wireless communication technology this dissertation is concerned with developing spectrum sensing algorithms in cognitive radio networks where a single or multiple cognitive radios crs assist in detecting licensed primary bands employed by single or multiple primary users first given that orthogonal frequency division multiplexing ofdm is an important wideband transmission technique detection of ofdm signals in low signal to noise ratio scenario is studied it is shown that the cyclic prefix correlation coefficient cpcc based spectrum sensing algorithm which was previously introduced as a simple and computationally efficient spectrum sensing method for ofdm signals is a special case of the constrained generalized likelihood ratio test glrt in the absence of multipath the performance of the cpcc based algorithm degrades in a multipath scenario however when ofdm is implemented by employing the inherent structure of ofdm signals and exploiting multipath correlation in the glrt algorithm a simple and low complexity algorithm called the multipath based constrained glrt mp based c glrt algorithm is obtained further performance improvement is achieved by combining both the cpcc and mp based c glrt algorithms a simple glrt based detection algorithm is also developed for unsynchronized ofdm signals in the next part of the dissertation a cognitive radio network model with multiple crs is considered in order to investigate the benefit of collaboration and diversity in improving the overall sensing performance specially the problem of decision fusion for cooperative spectrum sensing is studied when fading channels are present between the crs and the fusion center fc noncoherent transmission schemes with on off keying ook and binary frequency shift keying bfsk are employed to transmit the binary decisions to the fc the aim is to maximize the achievable secondary throughput of the cr network finally in order to reduce the required transmission bandwidth in the reporting phase of the crs in a cooperative sensing scheme the last part of the dissertation examines nonorthogonal transmission of local decisions by means of on off keying proposed and

analyzed is a novel decoding based fusion rule for combining the hard decisions in a linear manner

with wireless devices and applications booming the problem of inefficient utilization of the precious radio spectrum has arisen cognitive radio is a key technology to improve spectrum utilization a major challenge in cognitive radio networks is spectrum sensing which detects if a spectrum band is being used by a primary user spectrum sensing plays a critical role in cognitive radio networks however spectrum sensing is vulnerable to security attacks from malicious users in this dissertation we propose a malicious user detection scheme a density based ssdf detection scheme a conjugate prior based ssdf detection scheme and an anti jamming algorithm to achieve robust and secure cooperative spectrum sensing in cognitive radio networks performance analysis and simulation results show that our proposed schemes can achieve very good performance in detecting malicious users excluding abnormal sensing reports and defending the jamming attack thus improve spectrum sensing performance in cognitive radio networks

the wireless frequency spectrum is a very valuable resource in the field of communications over the years different bands of the spectrum were licensed to various communications systems and standards as a result most of the easily accessible parts of it ended up being theoretically occupied this made it somewhat difficult to accommodate new wireless technologies especially with the rise of communications concepts such as the machine to machine m2m communications and the internet of things iot it was necessary to find ways to make better use of wireless spectrum cognitive radio is one concept that came into the light to tackle the problem of spectrum utilization various technical reports stated that the spectrum is in fact under utilized many frequency bands are not heavily used over time and some bands have low activity cognitive radio cr networks aim to exploit and opportunistically share the already licensed spectrum the objective is to enable various kinds of communications while preserving the licensed parties right to access the spectrum without interference cognitive radio networks have more than one approach to spectrum sharing in interweave spectrum sharing scheme cognitive radio devices look for opportunities in the spectrum in frequency and over time therefore and to find these opportunities they employ what is known as spectrum sensing in a spectrum sensing phase the cr device scans certain parts of the spectrum to find the voids or white spaces in it after that it exploits these voids to perform its data transmission thus avoiding any interference with the licensed users spectrum sensing has various classifications and approaches in this thesis we will present a general review of the main spectrum sensing categories furthermore we will discuss some of the techniques employed in each category including their respective advantages and disadvantages in addition to some of the research work associated with them our focus will be on cooperative spectrum sensing which is a popular research topic in cooperative spectrum sensing multiple cr devices collaborate in the spectrum sensing operation to enhance the performance in terms of detection accuracy we will

investigate the soft information decision fusion approach in cooperative sensing in this approach the cr devices forward their spectrum sensing data to a central node commonly known as a fusion center at the fusion center this data is combined to achieve a higher level of accuracy in determining the occupied parts and the empty parts of the spectrum while considering rayleigh fading channels furthermore we will address the issue of high power consumption due to the sampling process of a wide band of frequencies at the nyquist rate we will apply the 1 bit quantization technique in our work to tackle this issue the simulation results show that the detection accuracy of a 1 bit quantized system is equivalent to a non quantized system with only 2 db less in signal to noise ratio snr finally we will shed some light on multiple antenna spectrum sensing and compare its performance to the cooperative sensing

document from the year 2022 in the subject physics technical physics grade a language english abstract cognitive radio offers non interfering use of spectrum which requires three main tasks spectrum sensing spectrum analysis and spectrum allocation the aim of this study is to focus on spectrum sensing in cognitive radio which is a recently introduced technology in order to increase the spectrum efficiency increasing efficiency of the spectrum usage is an urgent need as the number of wireless users is increasing rapidly cognitive radio arises to be a good solution to spectral crowding problem by introducing the opportunistic usage of frequency bands that are not heavily occupied by licensed users primary user since they cannot be utilized by users other secondary user than the license owners at the moment cognitive radio can sense the spectrum and detect the idle frequency bands thus secondary users can be allocated in those bands when primary users do not use those in order to avoid any interference to primary user by secondary users several spectrum sensing methods proposed in the literature are theoretically analyzed and interpreted in the sense of advantages and drawbacks

doctoral thesis dissertation from the year 2020 in the subject engineering communication technology grade a language english abstract cooperative spectrum sensing technique is used to maximize the utilization of unused licensed spectrum as the cooperation among the secondary users increases the detection performance increases which increases the average channel throughput and energy efficiency but it depends on the number of cooperative secondary users fusion rules channel conditions and detection threshold in this thesis average channel throughput energy consumption and energy efficiency are estimated for variable number of secondary users and detection thresholds using hard fusion rules i e and or and majority fusion rules from the results it has been observed that the performance of and fusion rule is better at low detection thresholds and for less number of secondary users the performance of or fusion rule is better at high detection thresholds and for large number of secondary users the performance of majority fusion rule follows the performance of and fusion rule at low detection thresholds and it follows the performance of or fusion rule at high detection thresholds however as the

number of cooperative secondary users increases the energy required for spectrum sensing and reporting sensing results to the fusion center increases which increases the energy consumption and reduces the energy efficiency therefore energy efficiency can be improved by maximizing the average channel throughput or by minimizing the energy consumption to minimize the energy consumption in cooperative spectrum sensing optimization technique has been proposed in this thesis and it is used for further improvement of energy efficiency with this optimization technique optimal number of cooperative secondary users are derived by maximizing the energy efficiency using and and or fusion rules but not with majority fusion rule because it is very difficult to estimate the optimal number of cooperative secondary users using majority fusion rule so optimization of final decision threshold was proposed in the existing methods to maximize the energy efficiency using majority fusion rule therefore and and or fusion rules are used in this work to optimize the number of cooperative secondary users

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 this book contains useful information regarding the different spectrum sensing techniques and their simulation procedures this book can be a good reference for masters students to explore recent research areas on cognitive radio based networks

cognitive radio networks crn will be widely deployed in the near future and this springerbrief covers some important aspects of it as well as highlighting optimization strategies in resource allocation and spectrum sensing in crns the cognitive approach in radio access is introduced in the first part of this springerbrief and then next the benefits of cooperative spectrum sensing are highlighted and a framework for studying it under realistic channel conditions is described new exact closed form expressions for average false alarm probability and average detection probability are derived in this scenario a novel approximation to alleviate the computational complexity of the proposed models are also discussed once the spectrum opportunities are identified efficient and systematic resource allocation ra shall be performed the second part of this springerbrief describes the taxonomy for the ra process in crn a comprehensive overview of the optimization strategies of the crn ra is also provided the device to device d2d communication scenario is discussed then as a case study and various optimization strategies for the application of the cr technology in the d2d realm is studied the application of advanced geometric water filling gwf approach in crn d2d environment for optimum resource allocation is presented in detail numerical results provide more insight quantitatively overall this book is suitable for a wide audience that include students faculty and researchers in wireless communication area and professionals in the wireless service industry

this work presents a method for real time detection of secondary users at the cognitive wireless technologies base stations cognitive radios may hide themselves in between the primary users to avoid being charged for spectrum usage to deal with such scenarios a cyclostationary fast fourier transform accumulation method fam has been used to develop a new strategy for recognising channel users under perfect and different noise environment conditions channel users are tracked according to the changes in their signal parameters such as modulation techniques matlab simulation tool was used to run various modulation signals on channels and the obtained spectral correlation density function shows successful recognition between secondary and primary signals we are unaware of previous efforts to use the fam characteristics or other detection methods to make a distinction between channel users as presented in this thesis a novel combination of both cognitive radio technology and ultra wideband technology is interdicted in this thesis looking for an efficient and reliable spectrum sensing method to detect the presence of primary transmitters and a number of spectrum sensing techniques implemented in ultra wideband and cognitive radio component uwb cr under different awgn and fading settings environments the sensing performance of different detectors is compared in conditions of probability of detection and miss detection curves simulation results show that the selection of detectors rely on the different fading scenarios detector requirements and on a priori knowledge furthermore result showed that the matched filter detection method is suitable for detecting signals through uwb cr system under various fading channels a general observation is that the matched filter detector outperforms the other detectors in all scenarios by an average of snr 20 db in the level of probability of detection pd and the energy detector slightly outperforms the cyclostationary detector in the level pd at snr 20 db furthermore the thesis adapts novel detection models of cooperative and cluster cooperative wideband spectrum sensing in cognitive radio networks in the proposed schemes wavelet based multi resolution spectrum sensing and a proposed approach scheme are utilized for improving sensing performance of both models on the other hand cluster based cooperative spectrum sensing with soft combination equal gain combination egc scheme is proposed the proposed detection models could achieve improvement of transmitter signal detection in terms of higher probability of detection and lower probability of false alarm in the cooperative wideband spectrum sensing model using traditional fusion rule existing worst performance of false alarms by measurement is 78 of the sensing bands at an average snr 5 db this compares with the proposed model which is by measurement 19 false alarms of scanning spectrum at the same snr for cluster cooperative wideband spectrum sensing the proposed combining methods shows improvements of results with a high probability of detection pd and low probability of false alarm pf at an average snr 16 db compared with other traditional fusion methods this is illustrated through numerical results

this thesis investigates different aspects of spectrum sensing in cognitive radio cr technology first a probabilistic inference approach is presented which models the decision fusion in cooperative sensing as a probabilistic inference problem on a

factor graph this approach allows for modeling and accommodating the uncertainties and correlations in the cooperative sensing system a constraint in the cognitive radios is the lack of knowledge about the primary signal and channel gain statistics at the secondary users therefore a practical composite hypothesis approach is proposed which does not require any prior knowledge or estimates of these unknown parameters in cognitive radios there is a fundamental trade off between the achievable throughput by the crs and the level of protection for the primary user in this thesis this trade off is formulated for the quickest sensing based crs by throughput analysis it is shown that for the same protection level to the primary user the quickest sensing approach results in significantly higher average throughput compared to that of the conventional block sensing approach detection delay is an important performance measure in spectrum sensing quickest detection aiming to minimize detection delay has been studied in other contexts and we apply it here to spectrum sensing to combat the destructive channel conditions such as fading various cooperative schemes based on the cumulative sum cusum algorithm are considered in this thesis furthermore cooperative quickest sensing with imperfectly known parameters is investigated and a new solution is derived which does not require any parameter estimation or iterative algorithm

spectrum management has become a crucial issue in wireless networks however optimal utilization of the spectrum among the different users is not a trivial task over the last two decades wireless communication has witnessed a significant increase in applications however fixed strategies for allocating the spectrum bands cannot handle multiple requirements simultaneously which is a core requirement of the emerging wireless applications more importantly licensed users or primary users pus in wireless networks are intermittently connected leading to spectrum underutilization all of these limitations make it imperative that efficient strategies be developed to manage the spectrum among multiple users or networks cognition as a component of intelligence has been employed in communication technologies such as cr networks for reasoning and learning goals from this perspective a cognitive radio network is an adaptive data network that applies cognition as an optimization tool aiming to optimize spectrum sharing among multiple secondary users sus in addition to the pus in an autonomous and dynamic way spectrum sensing is an important element of cognitive radio technology since its outcome is the basis for all the subsequent stages of the cognition cycle however with stand alone cognitive radio devices local spectrum sensing techniques such as energy detection technique might draw a false conclusion about the presence of a primary transmitter due to several reasons e g fading shadowing hidden node problem noise uncertainty etc cooperative sensing minimizes the uncertainty due to those factors by exploiting the spatial variation of sus then concludes one global decision about the pu s presence absence in this research work i propose an intelligent cooperative spectrum sensing system whereby the contextual information of each secondary user is augmented in the fusion process wherein a set of information acquired by several contributing sus are fused to optimize a global decision incorporating the contextual information of the

sus improves the spectrum sensing decision s reliability in the sense that false rejections and false acceptances are minimized and therefore utilization is optimized artificial neural networks as a machine learning and artificial intelligence tool has been employed as a fusion algorithm utilizing the context of every su to optimize final decisions experimental work is reported and discussed to demonstrate the effectiveness of the proposed technique

the rapid usage of wireless communications in personal commercial and governmental capacities efficient spectrum utilization has become a prime topic of interest most of the licensed bands suffer from under utilization and less spectral occupancy of spectrum cognitive radio technology promising solution to the problem of low spectral occupancy and inefficient utilization of the licensed radio spectrum a prime constituent of the cognitive radio technology is spectrum sensing energy detection ed is one of the popular spectrum sensing technique for cognitive radio in this work i proposed rtl 2832u sdr stick is suitable for energy detection based spectrum sensing method in this experiment we capture the real time signal coming from the bts over the different city in rural urban area using an rtl 2832u sdr stick to decide the frequency band available or not the gnu radio software allows for the implementation of energy detection spectrum sensing technique using the rtl sdr

spectrum sensing is the methodology used to determine the existence of a specific signal type in very low signal to noise power ratio snr environments spectrum sensing is one of the core technologies for the application of cognitive radio cr an ieee 802 22 working group has developed a standard to implement cr in the wireless services spectrum the spectrum however has already been allocated to the tv broadcast service which delivers atsc digital tv dtv signals cognitive radio systems are intended to co exist within the spectrum licensed to tv channels and operate on a non interfering basis at present there are three tv broadcast standards worldwide namely the atsc dtv standard 1 etsi dvb t standard 2 and the nsprc dmb t standard 3 the transmitted signals defined by these three standards possess different characteristics thus in order to apply cr in the dtv bands different spectrum sensing techniques are needed for these three broadcast standards in this thesis the focus is on the development of suitable spectrum sensing algorithms for the dtv signals defined by these three standards in addition wireless microphone devices use frequency bands that are located within the allocated dtv bands cognitive radio systems should transmit and receive using spectrum that is idle hence in this thesis spectrum sensing algorithms are also designed to detect the presence of wireless microphone signals when developing an algorithm to perform spectrum sensing for a specific signal we make use of particular characteristics embedded in the transmitted signals to design effective detector structures that can discriminate between the presence or absence of licensed information bearing signals one useful method employed in this thesis is to utilize the cyclostationary property that is present in most of the transmitted data

signals to perform spectrum sensing additionally the probability of false alarm and probability of misdetection performance metrics for signal detectors employing different spectrum sensing algorithms are analyzed the spectrum sensor operating characteristic curves for the different detectors are demonstrated by the use of computer simulations simulation results indicate that the spectrum sensing algorithms developed in this thesis can efficiently detect the presence of primary licensed signals when the snr is as low as 20 db finally selected spectrum sensing algorithms are implemented using an fpga based hardware platform the hardware implementation of the spectrum sensors verified their performance as well as demonstrated their practicality due to the low complexity of the algorithms

in order to efficiently utilize the spectrum the role of spectrum sensing is essential in cognitive radio networks the transmitter detection based techniques energy detection cyclostationary feature detection and matched filter detection is most commonly used for the spectrum sensing the energy detection technique is implemented in the 2 hop cooperative cognitive radio network ostbc is used for transmission of data in the 2 hop network the energy detection technique is simplest and gives good results at the higher signal to noise ratio snr values however at the low snr values its performance degrades moreover each transmitter detection technique has a snr threshold below which it fails to work robustly this book aims to find the most reliable and accurate spectrum sensing technique in the 2 hop cooperative cognitive radio network using matlab simulations a comparative analysis of three transmitter detection techniques has been made in terms of higher probability of detection in order to remove the shortcomings faced by all the three techniques a fuzzy combined logic sensing approach is implemented and compared with transmitter detection techniques

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