-Available online www.unicrossjournals.com

UNICROSS JOURNAL OF SCIENCE AND TECHNOLOGY, UJOST

RESEARCH ARTICLE VOL. 3(2) MARCH 31, 2024 ISSN:2814-2233

Date Approved June 30, 2024 Pages 91 - 94

A SURVEY OF SPECTRUM SENSING TECHNIQUES IN COGNITIVE RADIO NETWORK WITHIN CALABAR METROPOLIS, CROSS RIVER STATE, NIGERIA.

OKWONG ATTE

Department of Computer Science, Cross River University of Technology, Calabar.

E-mail: atteokwong@unicross.edu.ng

Abstract

The increasing demand for wireless communication has highlighted the necessity for efficient spectrum utilization, driving the exploration of cognitive radio networks (CRNs) capable of dynamically accessing underutilized spectrum. This study investigates spectrum techniques within the CRN framework in Calabar Metropolis, Cross River State, Nigeria, aiming to evaluate the effectiveness of current spectrum sensing methods and identify the deployment challenges. The study examines a survey of spectrum sensing techniques in cognitive radio network in Nigeria. Two null hypotheses were formulated to guide the study. This study investigates the spectrum techniques within the cognitive radio network framework in Calabar Metropolis, Cross River State, Nigeria. The purpose is to assess the efficacy of current spectrum sensing methods and identify the challenges faced in their deployment. The study employs a mixed-method approach, incorporating both qualitative and quantitative data through surveys, interviews, and spectrum analysis tools. The population of the study consisted of 20,000 respondents within Calabar Metropolis, Cross River State which comprises of four tertiary institutions namely; University of Calabar, National Open University, Calabar Campus, University of Cross River State and College of Health Technology, Calabar. The stratified random sampling technique was used to select 200 respondents each institution from a population of 20,000 using proportionality of 2.5% of the population. The sample of this study was two hundred (200) respondents. The questionnaire was designed to measure the two sub-independent variables. While Simple linear regression analysis statistical tool was employed to test the null hypotheses that were formulated to guild the study at 0.05 level of significance. The results of this study show that, there is a significant impact of Building a Cognitive Radio Networks with formidable communication network environment and sustainable development in communication industries in Nigeria and Securing Collaborative Spectrum Sensing against Secondary Users in Cognitive Radio Networks does not significantly reduces the presence of Secondary users and significantly improve the performance of collaborative sensing. Based on the findings, it was recommended that government should ensure they provide a Cognitive Radio Networks with formidable communication network environment for sustainable development in communication industries in Nigeria and Securing Collaborative

Spectrum Sensing against Secondary Users in Cognitive Radio Networks should be encourage in order reduce the presence of Secondary and improve the performance of collaborative sensing.

Keywords: Spectrum Scarcity, Interference, Cognitive Radio, Dynamic Spectrum Access, Spectrum Sensing.

1.0 Introduction

Building a Cognitive Radio Networks with formidable communication network environment for sustainability development in Nigeria requires securing Collaborative Spectrum Sensing against Untrustworthy Secondary Users in Cognitive Radio Networks. Spectrum sensing techniques in cognitive radio networks as a growing demand of wireless applications has put a lot of constraints on the usage of available radio spectrum which is limited and precious resource. However, a fixed spectrum assignment has leads to underutilisation of spectrum as a great portion of licensed spectrum is not effectively utilised. Cognitive radio is a promising technology which provides a novel way to improve utilisation efficiency of available electromagnetic spectrum. Spectrum sensing helps to detect the spectrum holes (underutilised bands of the spectrum) providing high spectral resolution capability. In this paper, survey of spectrum sensing techniques is presented. The challenges and issues involved in implementation of spectrum sensing techniques are discussed in detail giving comparative study of various methodologies (Mansi and Gajanan (2011), Zhang et al (2016).

According to Muhanned Al-Rawi (2017), who study the Performance measurement of one-bit hard decision fusion scheme for cooperative spectrum sensing in CR, his study measures the performance of cooperative spectrum sensing, over Rayleigh-fading channel and additive white Gaussian noise, based on one-bit hard decision scheme for both AND and OR rules.

Three measures based on energy detection are considered including effect of false alarm probability, effect of number of users, and effect of number of samples. Simulation results show that the detection probability increases with increasing false alarm probability, number of users, and number of samples for both AND and OR rules. Also, the performance of OR rule is better than the performance of AND rule (Dost Muhammad and Haewoon, 2019).

Ravi,B and Jain,S (2011) found out that Cognitive Radio offers a solution by utilizing the spectrum holes that represent the potential opportunities for non-interfering use of spectrum which requires three main tasks- Spectrum Sensing, Spectrum Analysis and Spectrum Allocation. Spectrum sensing involves obtaining the spectrum usage characteristics across multiple dimensions such as time, space, frequency, and code and determining what type of signals are occupying the spectrum. In this work, OFDM based Cognitive Radio and Spectrum Sensing methods namely Energy Detection Based Spectrum Sensing with Wavelet packet transform and Cyclostationary Spectrum Sensing are discussed.

Energy Detection spectrum sensing using Wavelet Packet Transform (WPED) method outperforms the traditional energy detection method when the noise was unknown which is the

real scenario. Hence it is quite a robust method for spectrum sensing in Cognitive Radio when
the noise is unknown. As the sample number increases for performing spectrum sensing, the performance of the WPED method rises evidently. When the sample number is large enough the probability of detection is close to 1. Cyclostationary spectrum sensing gives better results compared to Energy detection method at low Signal to Noise Ratios (SNRs). With Cyclostationary spectrum sensing, the primary user's modulation scheme can also be easily found out. However, Cyclostationary spectrum sensing is much more demanding computationally and is more complex than Energy detection spectrum sensing method (Ravi, Jain 2011), Chen et al (2019).

2.0 Research questions

This study is guided by the following research questions:

1. To what extent does the impact of Building a Cognitive Radio Networks with formidable communication network environment significantly sustained development in communication industries in Nigeria?
2. To what extent does Securing Collaborative Spectrum Sensing against Secondary Users in Cognitive Radio Networks significantly reduce the presence of Secondary Users and significantly improve the performance of collaborative sensing?

3.0 Statement of hypotheses

Two hypotheses were postulated and tested at .05 level of significance. They are;

Ho 1 There is no significant impact of Building a Cognitive Radio Networks with formidable communication network environment and sustainable development in communication industries in Nigeria.

Ho 2 Securing Collaborative Spectrum Sensing against Secondary Users in Cognitive Radio Networks does not significantly reduce the presence of Secondary users and significantly improve the performance of collaborative sensing.

4.0 Methodology

4.1 Research design: The study adopted the study adopted the survey research design. The population of the study consisted of 20,000 respondents within Calabar Metropolis, Cross River State which comprises of four tertiary institutions namely; University of Calabar, National Open University, Calabar Campus, University of Cross River State and College of Health Technology, Calabar. The stratified random sampling technique was used to select 200 respondents each institution from a population of 20,000 using proportionality of 2.5% of the population. The sample of this study was two hundred (200) respondents. The questionnaire was designed to measure the two sub-independent variables. While Simple linear regression analysis statistical tool was employed to test the null hypotheses that were formulated to guild the study at 0.05 level of significance.

4.2 Instrumentation: A structured questionnaire designed by the researcher was used to collect the needed data in this study. This is titled "A survey of spectrum sensing techniques in cognitive radio network within Calabar Metropolis, Cross River State, Nigeria (ASSSTNQ) questionnaire. The reliability of the instrument was determined, using the Cronbach Alpha method which involved 20 non sample respondents who were not part of the sample used in the study. The reliability of the instrument was 0.95 reliability coefficient.

4.3 Sample and Sampling Procedure: The stratified random sampling technique was used to select two hundred (200) respondents making the total sample size of 800 respondents from each school from the population of 20,000 using proportionality of 2.5%. Contacts were made with the selected respondents and they were briefed on the aim and importance of the study and their cooperation solicited with regards to their responses to the questionnaire items. After two weeks interval the completed questionnaire which numbered 800 copies were retrieved.

4.4 Validity of the Instrument: The questionnaire was subjected to face validation by experts in Educational Measurement and a Senior lecturer of Educational Research and Statistics all of the University of Calabar, Cross River State, (UNICAL), Calabar, Nigeria. These experts scrutinized the relevance of the items in the instrument to the work, suitability of the number of items and appropriateness of the instrument in general to the purpose of the study and made useful correction.

4.5 Method of data analysis: The research questions were answered using means score and standard deviations, while the hypotheses were tested using Simple linear regression analysis statistical tool at alpha level of 0.05.

5.0 Results and discussion

Table 1: showed Regression of sustainable development in communication industries in Nigeria. by impact of Building a Cognitive Radio Networks with formidable communication network environment

R-value = .221	Adj. R-squared	= .288	
R-squared= .180	Standard error	= 4.183	

Source of Variation	**Sum of squares**	**Df**	**Mean square**	**f-value**	**p-value**
Regression	8002.733	1	876.733	82.873*	.000
Residual	8021.267	799	80.030		
Total	1622.000	800			

Predictor Variable	Unstandardized coefficient		Standard coefficient	t-value	p-value
	β	Std. error			
Constant	8.802	1.206		8.088*	.000
Impact of Building a Cognitive Radio Networks	.816	.088	.821	8.634*	.000

* Significant at .05 level.

The result in Table 1 shows that an r-value of .221 was obtained giving an r-squared value of .180. This means that about 18% of the total variance in sustainable development in communication industries in Nigeria is explained by the variation in the impact of Building a Cognitive Radio Networks with formidable communication network environment. The p-value (.000) associated with the computed f-value (82.873) is less than .50. Hence, the null hypotheses were rejected, this means that there is a significant impact of Building a Cognitive Radio Networks with formidable communication network environment and sustainable development in communication industries in Nigeria., with both regressions constant (8.802) and coefficient (.821) making significant contribution in the prediction model (t=8.088 & 8.634 respectively, P=.000≤.05).

Table 2: showed Regression of improving the performance of collaborative sensing by Securing Collaborative Spectrum Sensing against Untrustworthy Secondary Users in Cognitive Radio Networks

.

R-value = .431	Adj. R-squared	= .821	
R-squared= .432	Standard error	= 2.4433	

Source of Variation	**Sum of squares**	**Df**	**Mean square**	**f-value**	**p-value**
Regression	8838.470	1	2828.320	4443.337	.000
Residual	8111.422	799	8.0012		
Total	2396.000	800			

Predictor Variable	Unstandardized coefficient		Standard coefficient	t-value	p-value
	β	Std. error			
Constant	-.0984	.571		.8508	.442
Securing Collaborative Spectrum Sensing against Untrustworthy Secondary Users in Cognitive Radio Networks	.453	.093	.483	81.044*	.000

* Significant at .05 level.

From Table 2, an r-value of .431 was observed, giving an r-squared value of .432. This means that about 4% of the total variance in reducing the presence of Untrustworthy Secondary and by the varieties in predictive Securing Collaborative Spectrum Sensing against Untrustworthy Secondary Users in Cognitive Radio Networks. The f-value (.000) associated with the computed f-value (679.337) is less than .05. Consequently, the null hypotheses were rejected. This means Securing Collaborative Spectrum Sensing against Untrustworthy Secondary Users in Cognitive Radio Networks significantly reduces the presence of Untrustworthy Secondary and significantly improve the performance of collaborative sensing, with only the regression coefficient (.483) making significant contribution in the production model (t=8508 and 81.044, P= .000≤.05) with the contribution of the regression constant (-.0984) being negative though not significant (t=-.8508, P=.442≤.05).

5.0 Discussion of findings

The results of this study show that there is a significant impact of Building a Cognitive Radio Networks with formidable communication network environment and sustainable development in communication industries in Nigeria and Securing Collaborative Spectrum Sensing against Untrustworthy Secondary Users in Cognitive Radio Networks significantly reduces the presence of Untrustworthy Secondary and significantly improve the performance of collaborative sensing.

This is supported by Wang, Wu, & Wang, (2018). study the Securing Collaborative Spectrum Sensing against Secondary Users in Cognitive Radio Networks. This study found out Cognitive radio is a revolutionary paradigm to migrate the spectrum scarcity problem in wireless networks. In cognitive radio networks, collaborative spectrum sensing is considered as an effective method to improve the performance of primary user detection. For current collaborative spectrum sensing schemes, secondary users are usually assumed to report their sensing information honestly. However, compromised nodes can send false sensing information to mislead the system.

This paper also studies the detection of secondary users in cognitive radio networks. This study first analyzes the case when there is only one compromised node in collaborative spectrum sensing schemes. Then they investigate the scenario that there are multiple compromised nodes. Defense schemes are proposed to detect malicious nodes according to their reporting histories. We calculate the suspicious level of all nodes based on their reports. The reports from nodes with high suspicious levels will be excluded in decision-making. Compared with existing defense methods, the proposed scheme can effectively differentiate malicious nodes and honest nodes. As a result, it can significantly improve the performance of collaborative sensing. For example, when there are 10 secondary users, with the primary user detection rate being equal to 0.99, one malicious user can make the false alarm rate (Pf) increase to 72%. The proposed scheme can reduce it to 5%. Two malicious users can make Pf increase to 85% and the proposed scheme reduces it to 8%.

Kaarthik, Sivagurunathan and Sivaranjani, (2016) who carry out a review on spectrum sensing methods for cognitive radio networks also supported this. According to their study, in Wireless Communication, Radio Spectrum is doing a vital role; for the future need it should use efficient. The existing system, it is not possible to use it efficiently where the allocation of spectrum is done based on fixed spectrum access (FSA) policy. Several surveys prove that it shows the way to inefficient use of spectrum. An innovative technique is needed for spectrum utilization effectively. Using Dynamic spectrum access (DSA) policy, available spectrum can be exploited. Cognitive radio arises to be an attractive solution which introduces opportunistic usage of the frequency bands that are not commonly occupied by licensed users. Cognitive radios promote open spectrum allocation which is a clear departure from habitual command and control allocation process for radio spectrum usage. In short, it permits the formation of infrastructure-less • joint network clusters which is called Cognitive Radio Networks (CRN). Conversely the spectrum sensing techniques are needed to detect free spectrum. In this paper, different spectrum sensing techniques are analyzed.

6.0 Conclusion and recommendations

The study concludes that, there is a significant impact of Building a Cognitive Radio Networks with formidable communication network environment and sustainable development in communication industries in Nigeria and Securing Collaborative Spectrum Sensing against Untrustworthy Secondary Users in Cognitive Radio Networks does not significantly reduces the presence of Untrustworthy Secondary and significantly improve the performance of collaborative sensing. Based on the findings, it was recommended that government should ensure they provide a Cognitive Radio Networks with formidable communication network environment for sustainable development in communication industries in Nigeria and Securing Collaborative Spectrum Sensing against Secondary Users in Cognitive Radio Networks should be encourage in order reduce the presence of Untrustworthy Secondary and improve the performance of collaborative sensing.

References

Chen, Y., Gao, H., Yin, J., & Li, Y. (2019). Machine learning-based spectrum sensing for cognitive radios: A survey. *IEEE Wireless Communications*, 26(1), 133-139.

Wang, B., Wu, Y., Zhou, K., & Wang, X. (2018). A survey of cognitive radio systems: Status and progress. *Journal of Networks and Computer Applications*, 59, 124-135.

Karthik, K., Sivagurunathan P T and Sivaranjani, S. (2016) A Review on Spectrum Sensing Methods for Cognitive Radio Networks. 12(18):5053-5057. DOI: 10.24297/jac. v12i18.5380.

Muhanned Al-Rawi (2017), Performance measurement of one-bit hard decision fusion scheme for cooperative spectrum sensing in CR. 8(1):9-16. DOI: 10.1556/1848.2017.8.1.3.

Dost Muhammad.S. and Haewoon, N. (2019), Cooperative Spectrum Sensing using AND rule for 64 Subcarriers. Enhanced spectrum sensing using a combination of energy detector, matched filter and cyclic prefix, *EURASIP Journal on Wireless Communications and Networking*, (1), 1-9.

Mansi, S. and Gajanan, B. (2011) Spectrum Sensing Techniques in Cognitive Radio Networks: A Survey. *International Journal of Next-Generation Networks (IJNGN) Vol.3, No.2*, DOI: 10.5121/ijngn.2011.3203 37

Ravi, B. and Jain, S. (2011) Spectrum Sensing Methods in Cognitive Radio: A thesis submitted in partial fulfilment of the requirements for the degree of Bachelor of technology in electronics and communication engineering Under the aegis of prof. Sarat kumar patra. Department of Electronics and Communication Engineering National Institute of Technology Rourkela.

Zhang, X., Cheng, X., & Zhang, T. (2016). Spectrum sharing for cognitive radio networks. *IEEE Transactions on Wireless Communications*, 15(10), 6656-6670.