PERFORMANCE ANALYSIS OF COOPERATIVE SPECTRUM SENSING OVER TWDP FADING IN CRN WITH HARD DATA FUSION

A Thesis
Submitted to the
Atmiya University,
For the Degree of

DOCTOR OF PHILOSOPHY
in
ENGINEERING & TECHNOLOGY

by

DOBARIA ANKIT DEVJIBHAI
Enrolment No. 190156002

Under the Guidance of

DR. VISHAL S. VORA
Department of Electronics and Communication Engineering

ATMIYA UNIVERSITY,
YogidhamGurukul, Kalawad Road,
Rajkot–360005, Gujarat (India)

May, 2023

Summary

CHAPTER 1: Introduction

The constant improvement of wireless devices and technology is a direct result of the ever-increasing popularity of wireless channels of communication. With the expanded variety of products and services that may be offered thanks to the modern integration and compatibility of wireless technologies, there is a great need for effective access to the radio frequency spectrum. Wider frequency ranges are required at higher rates. Mobile communication is challenging. The radio spectrum is used by a variety of regional communication devices. Spectrum for different communication protocols and standards has been allotted over time. The majority of the spectrum was already allocated, rendering the development of new wireless technologies unfeasible. Some strategies were launched to back up significant advances in wireless tech, radio systems, the Internet of Things (IoT), and machine-to-machine (M2M) communications. One potential answer is found in cognitive radio (CR). In order to combat the obvious spectrum underutilization brought on by the rigid spectrum allotment, cognitive radio (CR), a novel notion of reusing licensed spectrum in an opportunistic way, holds great promise. CR entails a radio channel setup where the transmitting and receiving devices are able to logically perceive a band of spectrum to determine if it is currently in use. Without disrupting the currently used band, it's able to be switched instantly to the next accessible one. This reduces interruption to primary users while allowing secondary users to make better utilization of the spectrum of radio frequencies.

CHAPTER 2: Cognitive Radio Networks

According to studies and real-world testing, the frequency allocated to traditional wireless systems is underutilized. There is a growing need for more radio spectrum, which is a finite resource, due to the proliferation of wireless technologies and their attendant uses. In addition to the high cost, bandwidth is scarce since the best frequencies are already in use by other companies. To find a vacant frequency without interfering with a licensed user's signal, a cognitive radio can adapt its operating circumstances based on its physical location. This improves the efficiency with which unused spectrum is utilized, hence making it easier for unlicensed users to gain access. Cognitive radios can adapt their transmission power and modulation methods to the characteristics of the underlying communication channel. These are the most important requirements that must be met to become a CR in the network. Spectrum sensing, decision making, spectrum sharing, and spectrum mobility are the several duties that a CR is responsible for performing in order to provide real-time interaction with the surrounding environment. Spectrum sensing wherein CR operates independently is referred to as single user sensing or non-co-operative spectrum sensing. Non-co-operative spectrum sensing has some limitations, such as noise inconsistency, fading, and effect of shadow.

CHAPTER 3: Spectrum Sensing Method and Fading Environment

Spectrum sensing is really useful for cognitive users (CR) in detecting the presence of primary user signals for the purpose of protecting the primary user's transmitted signal. Cooperation mechanisms amongst these tertiary users must also be built, and the provision of additional cognitive radio is also required. Several mechanisms exist for spectrum sensing, each with its own set of potential benefits and drawbacks. Ideally, a spectrum sensing device would provide a holistic image of the environment across the whole radio frequency range. In this way, the CR network can forecast spectrum usage by analyzing independent variables such as frequency, space and time. It has traditionally been a difficult task to distinguish the channel used by licensed (PU) user transmitters from those used by cognitive users. As a result, transmitter detection algorithms have their own unique significance in the field of spectrum sensing. The answer to these issues can be found in co-operative spectrum sensing (CSS). CSS takes the results from multiple SUs and averages them to make a better judgment.

CHAPTER 4: Proposed Approach

In order to address the issues of shadow effect and hiding stations, a non-cooperative spectrum sensing is impacted by the issue of the Secondary user being unable to scan the unoccupied spectrum. In non-cooperative spectrum sensing, hiding terminals and shadow effect can be a concern; however, using co-operative spectrum sensing can eliminate these issues. According to what was covered in the previous chapter, the co-operative spectrum sensing can be categorized into two separate groups: centralized and de-centralized. There is a risk that the efficiency of the flat network may decrease as its size increases. This is thus because significant increases occur when both the network's volume and the communication overhead across the network are increased. To reduce the size of a big homogeneous network system and improve its efficiency, making a cluster is one method that has gained a significant amount of interest. The network infrastructure is partitioned into appropriate groups while clustering, the make-up of which is defined by the network's characteristics and the needs of the functionality. In this section, we explore the investigation on the clustering method for de-centralized cooperative spectrum sensing.

CHAPTER 5: Performance Evaluation

Extensive simulations are conducted for the proposed work. The performance of proposed de-centralized co-operative spectrum sensing using clustering approach with two-stage hard decision strategies is analyzed using MATLAB simulations, Such as SNR Vs. missed-detection probability, false-alarm probability Vs. detection probability as well as SNR Vs. detection probability is obtained over TWDP fading channel. Also, the comparison analysis of such results between Centralized CSS and De-centralized CSS over two-wave with diffuse-power channel. Also, two-stage fusion strategy's results are compared with over other fading environments i.e. AWGN, Rayleigh, Rician, wei-bull channel.

CHAPTER 6: Conclusion

This dissertation analyses the detection capabilities of CSS and proposes a de-centralized co-operative spectrum sensing technique employs the clustering strategy, with each cluster employing a customized two-stage hard-decision strategies. De-centralized co-operative spectrum sensing using clustering strategy is examined for its detection rate in the environment of AWGN, Rayleigh, Rician, and TWDP fading channels. In this research, localized sensing is accomplished by conventional energy based detection method. For conventional centralized-CSS we utilize hard fusion decision strategies like the AND decision and the OR decision schemes. We derived the modified hard decision schemes such as OR__OR, OR__AND, AND__OR, and

AND__AND for the proposed D—CSS approach from the conventional centralized CSS model.

Additionally, we can generalize throughout all simulated graphs that increasing the number of secondary-users produces a superior result in terms of missed-detection probability. Also, the association among both P_{md} and P_d is inversely related to one another, therefore attaining the least missed-detection probability will result in improved detector performance. It can be seen that the detection values are enhanced by the proposed de-centralized-CSS methodology compared to the centralized-CSS strategy while the P_{fa} value is 0.1. From the overall observations the detection-probability is improved by the proposed OR_OR logic approach compared to other decision approaches. The proposed D_CSS using clustering technique reduces the likelihood of false detection regarding the existence or availability of PU. The suggested method with AND_AND logic over TWDP fading enhances detection efficiency.