CHAPTER 1
INTRODUCTION

1.1. Background

The need for higher data transmission speed is increasing in line with the change of communication which originally just a voice into multimedia communication form. The frequency spectrum is a limited resource so that the current conditions in which the scheme was given a static frequency allocation cannot meet the requirements for increased speed of data transmission in the future. Cognitive radio emerged as a solution to overcome the problem of the spectrum by introducing a way to use the frequency spectrum that is not in use (spectrum hole) by a licensed user at any given time without violating government regulations. One of the major components of cognitive radio is its ability to detect the availability of spectrum that has not been used and adapting its communication parameters and then exploit the use of frequency spectrum for the sake of generating higher data transmission speeds, so that in cognitive radio it is necessary to guarantee the quality of the results of detection spectrum about the existence of the spectrum hole before the use of the frequency spectrum.

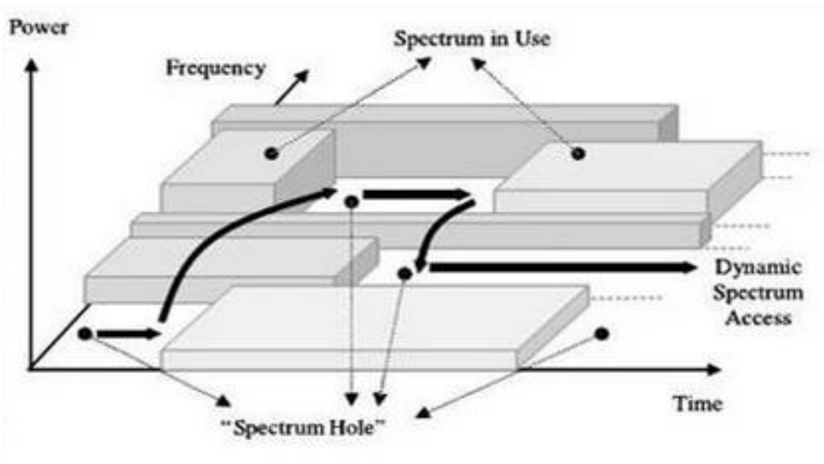

Figure 1.1. Spectrum hole in cognitive radio

The previous research in the field of spectrum sensing in cognitive radio in the paper titled Collaborative Spectrum Sensing in Cognitive Radio Using Hard Decision Combining with Quality Information [1], the signal detected by distributed detection using energy detector and its application has not been used for OFDM (Orthogonal Frequency Division Multiplexing) signal. Different types of spectrum sensing techniques based on cyclo-stationarity have been proposed by [5] and [6], whereas the spectrum sensing techniques based on energy detection proposed by [7] and [8]. A new method of signal detection was introduced in the paper titled Autocorrelation-Based Decentralized Sequential Detection of OFDM Signals in Cognitive Radios [2]. This paper introduces spectrum sensing method that is simple and computationally efficient for OFDM signal detection using autocorrelation coefficients of the OFDM signal.

In this study, the authors will examine the spectrum sensing methods for OFDM cognitive radio with a distributed detection using autocorrelation-based detector with 2-bit decision information. This research will propose a model and design of the threshold in each cognitive radio user to generate optimum fusion rule based on specific criteria in the fusion center to increase the probability of detection by using the methodology introduced in the papers titled Collaborative Spectrum Sensing in Cognitive Radio Using Hard Decision Combining With Quality Information [1] and Autocorrelation-Based Decentralized sequential Detection of OFDM Signals in Cognitive Radios [2].

1.2. Problem Definition

One of the major components of cognitive radio is its ability to detect unused spectrum availability so that in cognitive radio the quality of the results of spectrum detection about the existence of the spectrum hole plays a very important role before the use of the frequency spectrum. The current conditions in which detection using autocorrelation-based detector with 1-bit decision is still considered inadequate and there are still opportunities to improve the probability of detection using 2-bit decision.

1.3. Problem Limitations and Assumptions

Problem limitations and assumptions that will be used in this study are as follows:

1. The object of research is the OFDM signal in cognitive radio.
2. OFDM signal in question is the Gaussian distribution.
3. The synchronization signal is considered perfect.
4. There are two channels that will play a role, the sensing channel (channel between the source/primary transmitter and a local sensor) and the reporting channels (channels between local sensors and fusion center).
5. Sensing channel is assumed to use Rayleigh fading.
6. The design of local sensor or detector is using autocorrelation-based detector.
7. Reporting channel between collaborative cognitive radio user and a fusion center is considered perfect (no propagation effects, no collision, and no interference).
8. This study is using a number of sensors and a fusion center.
9. Fusion rules on the fusion center using Neyman-Pearson approach theorem.

10. The performance of the proposed scheme is studied through the theory and the results are validated and verified using the simulation of signal processing software.

1.4. Research Objectives

The objective of this study is to obtain more accurate OFDM spectrum signal detection using autocorrelation-based detector with 2-bit decision information. This research will propose a model and design of the threshold in each cognitive radio user to generate optimum fusion rule based on specific criteria to increase the probability of detection so that the quality of the results of spectrum detection will be more accurate.

1.5. Hypothesis

The hypothesis of this study is that if using autocorrelation-based detector and a 2-bit decision information in the detection of cognitive radio spectrum for OFDM, there will be an increased probability of detection and the quality of detection more accurate than an autocorrelation-based detector with 1-bit decision information.

1.6. Scope of Work

This study was carried out by performing the following activities:

1. Perform a system design which is a distributed detection system using a synthesis of the autocorrelation-based detector and the hard decision combining with 2-bit decision information with the following steps:
    a. Design a configuration system that consists of the following components:
        i. Primary User Transmitter
        ii. Sensing Channel
        iii. Local Detector
        iv. Reporting Channel
        v. Fusion Center
    b. Design a local detector to detect the OFDM signal using an autocorrelation-based detector, and then to seek the common distribution fusion rule as a function of the thresholds on each cognitive radio user which has given 2-bit decision information to the fusion center.
    c. Find the distance between the mean of the distribution T_{FC}/H_0 and T_{FC}/H_1 at the fusion center using J-Divergence. The J-Divergence if maximized will generate increasingly better performance.
2. Perform simulations using the software.

When performing the simulation, each local detector will detect independently using the method of the autocorrelation-based detector and 2-bit decision information. Then the fusion center will do the calculations to generate the global decision.

3. Perform the testing through simulation software.

   The testing will be done by varying the number of sensors and SNR using one fusion center.

4. Conduct the performance analysis of spectrum detection.