CHAPTER 1
INTRODUCTION

Wireless communication demands a reliable and high capacity can not be separated from the availability of resources in the form of sufficient frequency spectrum. The frequency spectrum is used to data transmission in fact provided by the government only to users who have registered. The name is Primary User (PU) / licensed user. However, the use of the frequency spectrum used by PU inefficient. Because it, is not always used by those who have legal access (PU). If there are others who do not have legal access (Secondary User / SU) wants to access the data, the frequency spectrum can not be used even though PU is not being used. To solve these problems requires a new mechanism that can work in resource management more flexible. So that, spectrum frequency resources can be used by SU when the PU is not currently using the frequency spectrum, this is the result of a measurement of data [2].

To solve this problem, the cognitive radio (CR) [3] has been regarded as a technology to solve the problem of future communications. One functionalist of CR is spectrum sensing that serves to determine the unoccupied channels. A CR system is an intelegent wireless communication system that is aware of its surrounding environment, learn from the enviroment, and adapts its operating parameters in real time [1]. One of fundamental requirement of this system is the ability to identify the white space in the spectrum of interest by the secondary users. Therefore, Spectrum sensing should be periodically performed to efficiently recognize the operation of primary user systems and other CR systems [12].

In this thesis we assumption that circumstance is downlink [12]-[16]. Actually we can do sensing in which there are legal access (PU) [10]. Therefore, we do using assumption if BTS is Transmitter and Cellphone is Receiver (Downlink)

1.1 State of The Art

Generally, spectrum sensing methods including matched filter [1], energy detector [4], and cyclostationary detection [5]. Each has advantages and disadvantages. Energy Detector is a major and basic method. Unlike other methods, energy detection does not need any information of the signal to be detected and is robust to unknown multipath fading. However, energy detection is vulnerable to the noise uncertainty [6] because the method relies on the knowledge of accurate noise power. In practice, it is very difficult

to obtain the accurate noise power. To overcome this shortage, [7] propose new methods based on the statistical covariance or auto-correlations of the received signal.

The statistical covariance matrices or auotocorrelations of signal and noise are generally difference. The statictical covariance matrix of noise is determined by the receiving filter. Therefore its structure is known to the receiver. Based on this structure, we can turn the covariance matrix of the received signal into another matrix. When there is no signal, the o-diagonal elements of the resultant matrix are zeros. However, when there are signals, some of the o-diagonal elements of the resultant matrix are not zeros. Based on this property, we can compare the o-diagonal elements with the diagonal elements of the transformed covariance matrix to detect signal existence. But, [7] didn't work well. If the assumption channel is multi-antenna.

Another method reduced, without estimating the noise variance, [8] proposed a method that involves a multiantenna receiver. The method is referred to as the maximum-to-minimum ratio eigenvalue detector, which employs the ratio of the maximum eigenvalue to the minimum eigenvalue of the covariance matrix of the received signal. The performance is evaluated by resorting to the random matrix theory, and the threshold for detection is given in a Because trend positive using multi-antenna, we propose for multi-antenna CR sensors a class of spectrum sensing methods that require no information about the primary users or the channels from the primary to the secondary users. The proposed methods utilize the eigenvalues of the sample covariance matrix of the received signal vector from multiple antennas, taking advantage of the fact that in practice, the primary signals to be detected will either occupy a subspace of dimension strictly smaller than the number of antennas, or have a non-white spectrum in space. Using the generalized likelihood ratio test (GLRT) paradigm [1].

GLRT approach can derive blind detector with own assumption detector such as: PU signal, channel, noise variance, amplitude and etc., But GLRT method also derivation many algoritm. so in this thesis we want to find the advantages and disadvantages.

Acctually, there are several algorithm that cann't derive distribution H_0 and H_1. According to [9] signal proccesing can combine with bootstrap. Without, we know about distributin H_0 and help for detector type-3 [10] to get assumption P_d. Therefore, we used bootstrap for several detector in this thesis.

1.2 Description Method

Many spectrum sensing methodology that no requires primer or noise variance information signals. That have been proposed in the literature. Generally, they take advantage of the correlation structure in data received. In [7], the absolute value of

covariance (CAV) is heuristic detector structures derived from the covariance matrix used the correlation identity in general. This provides a new indicator for detection. As a result, the eigen-based sensing scheme has derived from the covariance matrix [8]. Another detection approach Generally likelihood ratio test (GLRT). Based on arithmetic and geometric (AGM) [11] and GLR [12]. The detector is able to reliably identify correlated signal and independent identically distributed (iid). In addition there are other methods by using the maximum-minimum eigenvalue (MME) detector [8] used a different approach using GLRT. This method is called GLRD, can be used regardless of major Rank [13]. Recently detector based EMR (Eigen Moment Ratio) [14], this detector does not care about the form of a matrix of the signal receiver.

The main difference the above literature, is that in this thesis we use resampling to develope the algorithms for spectrum sensing. It includes resampling in fixed sample size testing. The reason of using bootstrap resampling is twofold. First, bootstrap based testing is able to work properly with a small sample size, when the devised asymptotic test fails. Second, bootstrap resampling is an appropriate choice to alleviate the problem of intractable distribution of a statistic. These bootstrap properties are explored to achieve the objective of developing spectrum sensing algorithms with a short sensing time. in fact, there are three types of statistical test algorithms. First, statistical test algorithms that can be derived by the researchers to get the value of the probability of detection (Pd) without assuming the number of samples very much. Second, statistical test algorithms that can be derived by the researchers to get the value of the probability of detection (Pd) with the assumption that the number of samples very much. Third, researchers can not completely degrade statistical test algorithms [10]

In this thesis, proposed using multi-antenna CR sensor on spectrum sensing method is not sensitive to the uncertainty of noise to the signal space time block code (STBC)[15]. With the use STBC as PU then this thesis compares other methods that match the STBC. [16] is a detection method and approach results GLRT also suitable for STBC. The name algorithm is TSTBCGLRT.

Due to the many methods that have been published. The author wants to assess the advantages and disadvantages of each method before. Assuming STBC as PU and geometrically-Based Single Bounce (GBSB) [17] as multi-antenna.

1.3 Problems

Issues that will be formulated in this thesis as follows:

1. Spectrum sensing method that is often used in multiantenna is the Energy Detector, Energy Detector can't detect. if power noise in a condition of uncertainty. it

makes we have to find new methods to overcome the problem.

2. GLRT approach method produces different algorithms, so we need to find weaknesses and strengths of the algorithm is applied to the multi-antenna technology
3. There are several statistical tests algorithm GLRT that don't reduce the algorithm to get the value of the probability of detection (P_d) such as type-3

1.4 Objectives

The purpose of this thesis is:

1. Evaluate algorithm GLRT approach and to improve methods of energy detection that is not resistant to the noise uncertainty on detection using multiantenna
2. Evaluate the advantages and disadvantages algorithm GLRT Approach in the multi-antenna using several factors such as; increase in antenna, channel scheme correlated and uncorrelated channel scheme
3. Can determine the value of the assumption of the probability of detection (Pd) on a statistical test algorithms of type-3

1.5 Scope Of Work

1. In this thesis focuses only on spectrum sensing functionality and does not address other functionality on Cognitive Radio such as spectrum sharing, spectrum mobility, spectrum management
2. Evaluation uses algorithms GLRT approach
3. Evaluation test statistical algorithm GLRT type-3 using the bootstrap method
4. Evaluation using PU signal on MIMO STBC and channel-based GBSB
5. Evaluation is used in fixed wireless
6. Evaluation is used in downlink circumstance
7. Evaluation didn't explain time computation for all method

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1.6 Hypothesis

Method GLRT approach [1] will produce a new algorithm that can be used in noise uncertainty and multi-antenna. Algorithms TAGM [11] used when matrix signals received is fullrank form, algorithms TGLR [12] used when the matrix signal received is rank-1 form, TSTBCGLRT algorithm [16] used by PU signals using MIMO STBC, TEMR algorithm is used when we do not know the form of a matrix of the signal received.

TEMR [14] is best detector when we don't know about form matrix compared with TAGM and TGLR. they method must know about the form matrix. But , It is not

the only one influence to know about performance. TSTBCGLRT is also best because method GLRT approach to reduced TSTBCGLRT using estimation STBC as PU signal. So the hypotesis, both of TEMR and TSTBCGLRT is best

Then subsequent studies used other methods to improve GLRT approach. One method used is the bootstrap method. With the help of the bootstrap [9] method can improve and determine P_d of the detector when the sample size slightly and also can help detector type-3. Last, advantage of bootstrap. This method don't care about distribution H_0. It only resampling data from signal received.

1.7 Considering With Previous Work

TABLE 1.1: Consedering Table

NO	Previous Research	New Research
1	Signal used QPSK and QAM modulated by using one algorithm GLRT approach that compared with the, Energy Detection	QAM modulated signals used with MIMO STBC 2x2 and then do some GLRT approach as a comparison, algorithm then look for weaknesses and strength
2	Assumptions Multi-antenna uses a lot of microphone manually	Assumptions Multi-antenna using a software application in accordance with the application GBSB
3	Multi-antenna has a limitation the number of 2-8 antennas are used to detect using GLRT approach	Assumptions Multi-Antenna from 2-32 are used to detect using the GLRT approach
4	Did not discuss the Multi-antenna with a sample slightly and for detector type-3.	Resolving on Multi-antenna with a sample slightly and detector type-3. Do the bootstrap method to resolve the issue