# Optimization of Mean Square Error and BER in Spectrum Sensing Cognitive Radio Networks

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**Abstract—** Error free transmission and increase in multimedia applications is one of the main aims of wireless communication. Massive system is the system to improve the reliability of the WiMAX system. The fundamental tasks that are used in the cognitive radio (CR) networks are spectrum shaping capability and multi carrier systems. In these structures activation of fundamental (primary) users will generate a defined number of sub carriers in the secondary users. In this paper, the design of massive system using Matched Filter Detection Spectrum Sensing Cognitive Radio Network is presented. A matched filter is a spectrum-sensing method that detects the free portions of the primary user's spectrum and allocates it to secondary users. It derives from cross-correlating an unknown signal with known ones to detect the unknown signal's presence based on the basis of its SNR. Accordingly, an efficient scheme is developed here that is having better BER against a different transmitter and receiver system.

**Keywords-** WiMAX, Massive System, Cognitive Radio, Matched Filter

## I. INTRODUCTION

The exponential growth in wireless communications has resulted in an ever-increasing demand for deployment of wireless services in licensed as well as unlicensed frequency spectrum. The practice of fixed spectrum assignment leads to inefficient spectrum utilization, as shown by several studies. Cognitive radio (CR) is an effective and efficient technology that has emerged to address this issue. CR increases spectral efficiency by enabling access to the intermittent periods in unoccupied frequency bands that are known as white space or spectrum holes [1,2].

The fundamental task of each Secondary User (SU) in CR networks, in the most primitive sense, is to detect if the licensed users, also known as primary users (PUs), are present and determine the vacant spectrum, if the PUs are absent. In order to achieve this, SUs perform spectrum sensing which is a process of sensing the RF environment [3-6]. The first objective of spectrum sensing is that SUs should not cause harmful interference to PUs. SUs need to achieve this by switching to an available band or by limiting the interference to PUs to an acceptable level. The second objective of spectrum sensing is that SUs should identify efficiently and utilize the spectrum holes to meet the throughput and quality-of-service (QoS) requirements. Therefore, the detection performance in spectrum sensing is vital to the performance of primary as well as CR networks. This fact highlights the importance of a spectrum sensing algorithm in a cognitive radio network. The detection performance of traditional spectrum sensing algorithms is often deteriorated by noisy environments, multipath fading and shadowing effects [7, 8].

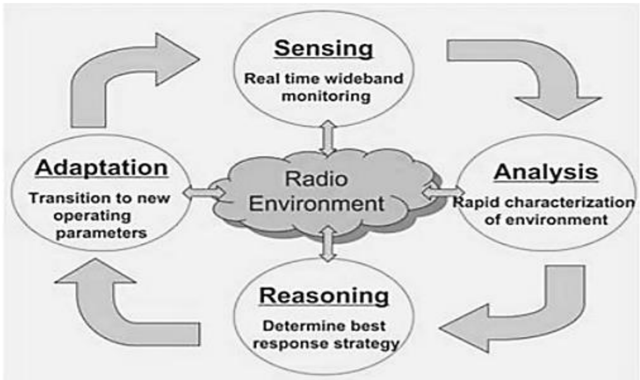


Fig. 1: Cognitive Cycle

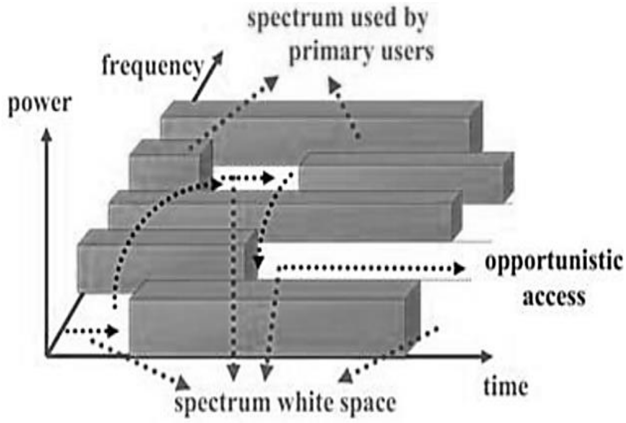


Fig. 2: Opportunistic Usage of Spectrum Holes

Therefore, a CR enabled node in the network adapts dynamically to re configure several parameters such as the operating frequency (to take advantage of detected spectrum holes on different frequency bands), modulation and channel coding (to adapt to the requirements of application and the instantaneous conditions of channel quality), transmission power (to control the possible generated interference), and communication technology (to adapt to specific communication needs). Depending on the characteristics of the detected spectrum holes, as shown in Figure 1 and Figure 2, the CR enables to switch to different spectrum bands opportunistically [4], while the transmitter and receiver parameters are reconfigured accordingly.

## II. CR NETWORK ARCHITECTURE

The possible architecture of a CR network as defined is shown in Figure 3. The components of such CR network architecture can be classified into two groups as primary network and secondary network (i.e. cognitive radio network).

Primary network: A primary network is referred to an existing network infrastructure, where the nodes called primary users (PUs) have authorized license for exclusively accessing a certain frequency band. Examples of such networks include the cellular and the TV broadcast networks. Primary user (PU) activities are controlled through the primary base-stations in infrastructure based the primary network. Since the PUs have their priority in spectrum access, the operations of PUs should not be affected by any other unlicensed or secondary users.

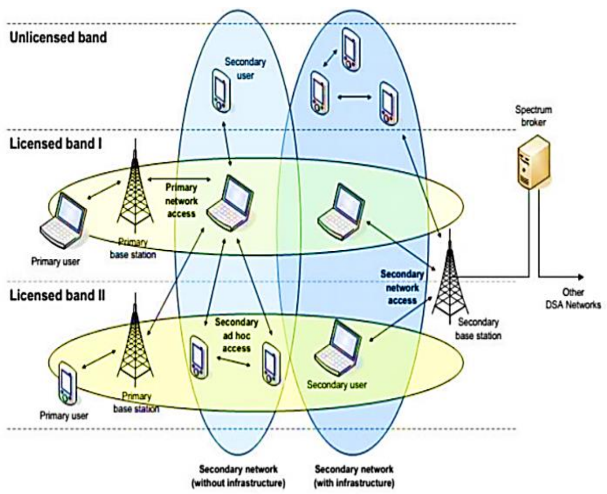


Fig. 3: Cognitive Radio Network Architecture

Optional system: An auxiliary or unlicensed system is eluded to a system, with fixed foundation or dependent on specially appointed correspondence guideline, without permit to work in an ideal authorized band. Subsequently, to share the authorized range band with essential systems, the extra functionalities are utilized by the hubs called CR clients/auxiliary clients (SUs). The foundation based optional systems are outfitted with a focal element called CR base station, which executes a solitary bounce association with SUs. Then again, the optional specially appointed systems have no framework spine and a SU can speak with different SUs through the impromptu association on both authorized and unlicensed range groups. Besides, optional systems may incorporate range dealers, which can assume a job in sharing range assets among various auxiliary systems [9, 10].

With regards to organize design, the range the executives functionalities are actualized by various elements. For example, in foundation based engineering, the range merchant is in charge of organizing the undertakings of range detecting, choice and the executives (sharing and versatility), while in specially appointed design; CR hubs themselves are in charge of range detecting, choice and the executives. The previous requires a committed control direct though in framework less designs utilization of devoted control channel is discretionary [11, 12].

## III. PROPOSED METHODOLOGY

Based on the spectrum sensing schemes, the cognitive radio is proposed to reduce the computational complexity in MIMO-OFDM system. On the one hand, apply the matching filter algorithm in a different antenna, and employ the linear property of Inverse Fast Fourier transform (IFFT) to increase the number of candidate sequences so as to achieve better SNR and lower MSE performance.

The techniques based on energy detection estimate the energy of the received signal and compare it with a fixed predefined threshold value. Such a general approach lacks adequate reliability and may lead to inaccurate detection in sensing a wideband spectrum. The conventional methods of wideband sensing are Nyquist based which requires high sampling rates. In order to sense the wideband radio spectrum, communication systems can use multiple RF frontends simultaneously but, it can result in long processing time, high hardware cost, and computational complexity. Considering the limitations and need for improvement in spectrum sensing algorithms, the main motivation of the proposed work in this research is enhancement of detection performance of sensing algorithms and to propose improved spectrum sensing algorithms.

To analyze a signal in the time domain, IFFT (Inverse Fast Fourier Transform) is applied and converted it from parallel to serial. OFDM signal to add a Cyclic Prefix (CP), which helps avoiding interference between OFDM symbols.

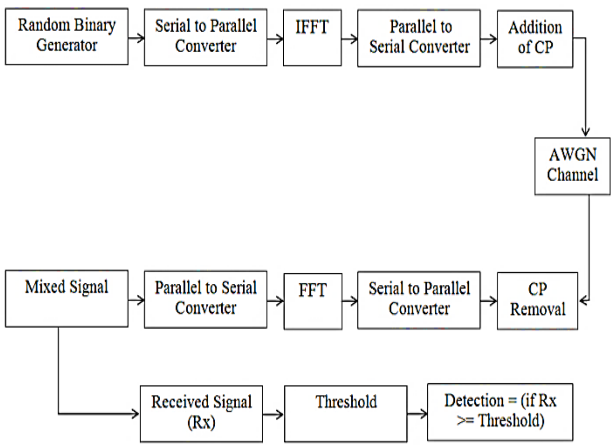


Fig. 4: Design of MIMO-OFDM System using Matched Filter Spectrum Sensing Cognitive Radio Network

This sign is then gone through an Additive White Gaussian Noise (AWGN) channel. At the collector end, the CP is expelled and the sign is changed over from sequential to parallel to get the first, with FFT connected to every image for investigation in the recurrence area. After demodulation, the sign is cross corresponded with that of a period moved neighborhood oscillator.

We executed our circuit (Figure 4) in MATLAB programming, with the primary parameters depicted underneath. We produced an irregular double signal in a sequential way. To examinations a sign in the time space, we apply IFFT (Inverse Fast Fourier Transform) and convert it from parallel to sequential OFDM sign to

Include a cyclic prefix (CP), which maintains a strategic distance from obstruction between OFDM images. We at that point feed this sign through an Additive White Gaussian Noise (AWGN) channel. At the collector end, the CP is expelled and the sign changed over from sequential to parallel to get the first, with FFT connected to every image for examination in the recurrence space. After demodulation, the sign is cross corresponded with that of a period moved nearby oscillator.

SNR to decide if the sign is missing or present; if they got sign is more prominent than the limit esteem, there will be a discovery, generally not:

$$H_0: y(t) = n(t) \qquad \text{PU is absent}$$

$$H_1: y(t) = h*s(t) + n(t) \qquad \text{PU is present}$$

## IV. SIMULATION RESULT

Simulation experiments are conducted to evaluate the SNR VS Bit Error Rate (BER) performance of the proposed matched filter detection spectrum sensing 1×1 system is shown in figure 5. To analysis random binary generator signal, a signal in the frequency domain, an IFFT is applied to the signal and converted from parallel to serial for the addition of the CP, one transmitter antenna and one receiver antenna through an Additive White Gaussian Noise (AWGN) channel.

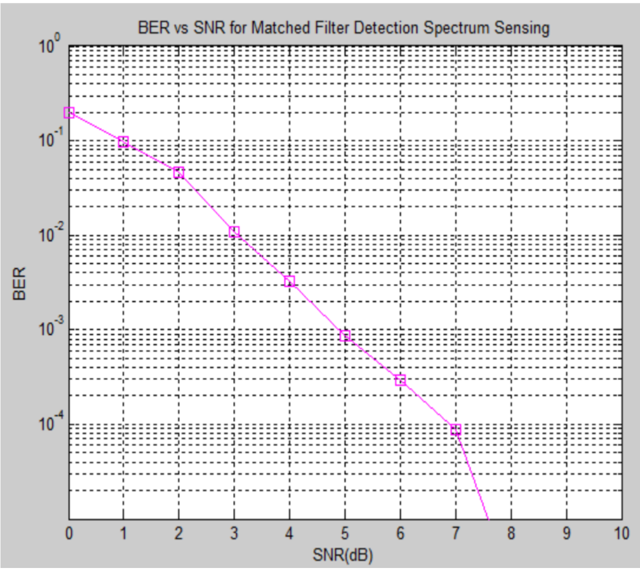


Fig. 5: BER vs SNR for Matched Filter Detection Spectrum Sensing 1×1 System

Simulation experiments are conducted to evaluate the SNR VS BER performance of the proposed matched filter detection spectrum sensing 2×2 system is shown in figure 6. To analysis random binary generator signal, the signal in the frequency domain, an IFFT is applied to the signal and converted from parallel to serial for the addition of the CP, two transmitter antenna and two receiver antenna through an Additive White Gaussian Noise (AWGN) Channel.

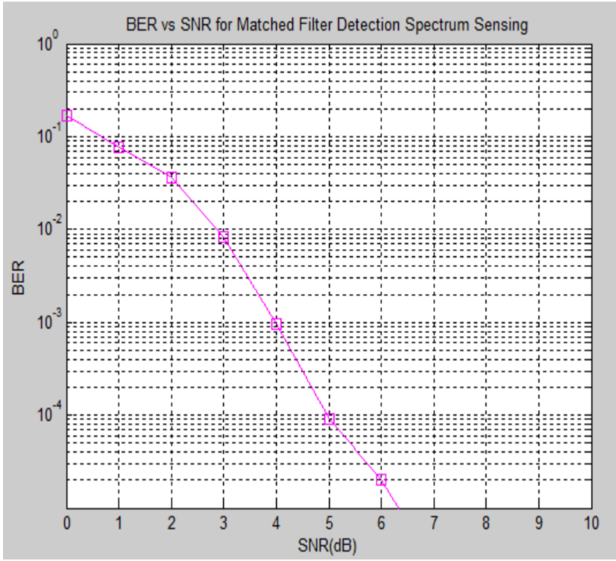


Fig. 6: BER vs SNR for Matched Filter Detection Spectrum Sensing 2×2 System

Simulation experiments are conducted to evaluate the SNR VS BER performance of the proposed matched filter detection spectrum sensing 4×4 system is shown in figure 7.

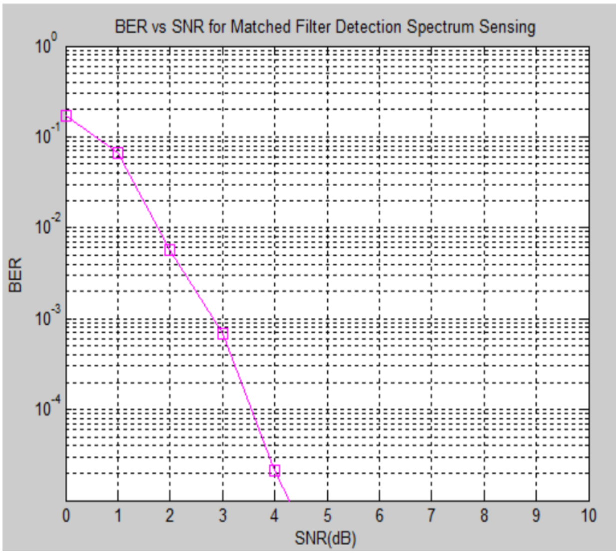


Fig. 7: BER vs SNR for Matched Filter Detection Spectrum Sensing 4×4 System

Simulation experiments are conducted to evaluate the SNR VS BER performance of the proposed matched filter detection spectrum sensing different system is shown in figure 8.

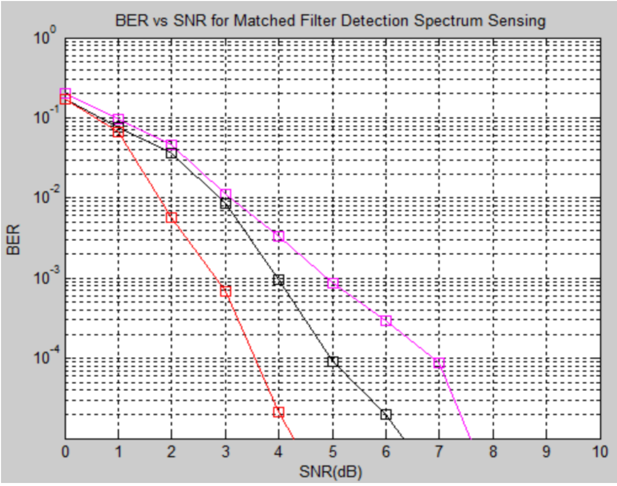


Fig. 8: BER vs SNR for Matched Filter Detection Spectrum Sensing Different System

Simulation experiments are conducted to evaluate the SNR VS BER performance of the proposed matched filter detection spectrum sensing and cyclo-stationary detection spectrum sensing is shown in figure 9.

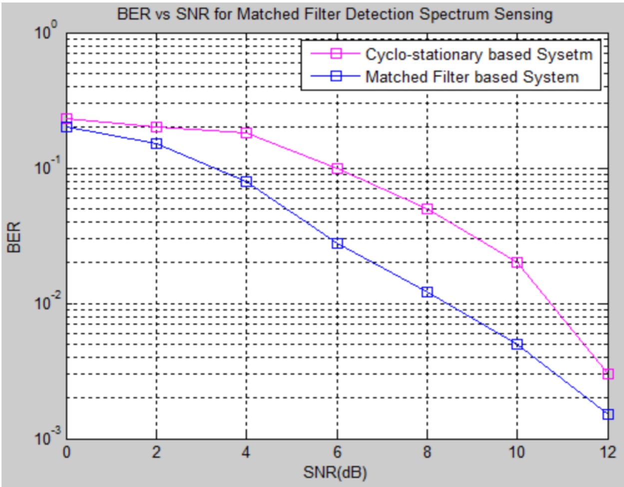


Fig. 9: Comparative Result

Table 1 the tabular illustration of the performance of different SNR discussed in this research work in term of Bit Error Rate (BER). From the analysis of the results, it is found that the proposed matched filter detection spectrum sensing Cognitive Radio Network gives a superior performance as compared with the previous method.

Table 1: Comparative Result of BER

| BER | SNR (dB) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 6 | 8 |
| Previous System | $3.1\times10^{-1}$ | $1\times10^{-1}$ | $4.1\times10^{-2}$ | $6.1\times10^{-3}$ | $3\times10^{-4}$ | 0 | 0 |
| Proposed System | $1.7\times10^{-1}$ | $6.7\times10^{-2}$ | $6\times10^{-3}$ | $7\times10^{-4}$ | $2\times10^{-5}$ | 0 | 0 |

## V. CONCLUSION

Coordinated sifting is known as an ideal strategy for discovery of essential clients when the transmitted sign is known. It is a direct channel intended to amplify the yield sign to commotion proportion for given info signal. It is gotten by corresponding a known sign, with an obscure sign to distinguish the nearness of the known sign in the obscure sign. This is proportionate to convolving the obscure sign with a period switched form of the sign. Convolution is at the core of coordinated channels.

Convolution does basically with two capacities that it places one capacity over another capacity and yields a solitary worth proposing a degree of closeness, and after that it moves the primary capacity an imperceptibly little separation and finds another worth. The final product comes as a chart which tops at the point where the two pictures are generally comparative. The coordinated channel is the ideal straight channel for boosting the Signal to Noise Ratio (SNR) within the sight of added substance White Gaussian Noise. The presentation of executed strategy including remote correspondence is better when contrasted with the past system calculation.

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