Spectrum Sensing Techniques & Data Security in Cognitive Radio Networks

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Abstract— The developing demand of wireless applications has increased a lot of constraints on utilization of available radio spectrum. Therefore for efficient utilization of spectrum, we need to sniff the spectrum to determine whether it is being used by primary user or not. Cognitive radio (CR) enables dynamic spectrum access. The biggest challenge related to spectrum sensing is in developing sensing techniques which are able to detect very weak primary user signals while being sufficiently fast and low cost to implement. Spectrum sensing helps to detect the underutilized bands of the spectrum which provides high spectral resolution capability. In this paper various spectrum sensing techniques and their performance analysis is presented.

Key words: Cognitive Radio, Spectrum Sensing, Primary User, Secondary User, Quantum Key

I. Introduction

The Federal Communication Commission (FCC) regulates the electromagnetic radio spectrum which is a valuable and limited natural resource. The regulation is based on licensing of a particular band. Only a licensed user is authorized to use that band. The increase in wireless devices and applications has led available Electromagnetic Spectrum to get crowded. The available Spectrum is found to be underutilized due to static allocation of spectrum. This underutilization of spectrum can be resolved by implementing Cognitive Radio (CR) technology.CR technology is considered as the best solution because of its ability to rapidly and autonomously adapt operating parameters to changing requirements and conditions.

The unused license band can be made available to the secondary users, who have no spectrum licenses in the absence of primary users through Cognitive Radio. Spectrum sensing is the ability to detect the spectral opportunities accurately for the secondary users without any harmful interference to primary users. Hence Spectrum sensing is the prime function of Cognitive Radio.

A. Cognitive Radio

A cognitive radio (CR) is a radio that can be programmed and configured dynamically to use the best wireless channels in its vicinity to avoid user interference and congestion. Such a radio automatically detects available channels in wireless spectrum, then accordingly changes its transmission or reception parameters(e.g., frequency band, modulation mode, and transmission power)in real time to allow more concurrent wireless communications in a given spectrum band at one location. This process is a form of dynamic spectrum management. Cognitive Radio mainly does four functions:

1) Spectrum Sensing

A cognitive radio senses the radio environment. Finds available spectrum band, the information related to its parameters and detects spectrum holes. This property is termed as spectrum sensing.

2) Spectrum Management

Once the spectrum holes or white spaces are detected, cognitive radio selects the available white space. This is termed as spectrum management.

3) Spectrum Sharing

CR allocates the unused spectrum (white space) to the secondary user as long as primary user does not need it. This property is termed as spectrum sharing.

4) Spectrum Mobility

The function related to the variation of operating frequency band of CR users is termed as Spectrum mobility. For example when a licensed user begins to access a radio channel which is currently being used by a secondary user, the secondary user can change idle spectrum to an active spectrum band.

II. Spectrum Sensing Methods

Spectrum sensing is the prime function of cognitive radio networks. In spectrum sensing there is a need to find spectrum holes in the radio environment for CR users. A CR cannot transmit and detect the radio environment simultaneously, thus, we need such spectrum sensing techniques that take less time for sensing the radio environment. Some of the most common spectrum sensing techniques in the cognitive radio is:

A. Narrowband Spectrum Sensing

Narrowband Spectrum Sensing as the name suggests it senses spectrum for spectral opportunities for secondary users over a narrow range of frequencies. Energy detection, matched filtering and cyclostationary feature detection are the traditional narrow band sensing techniques.

1) Energy Detection

Energy detection does not require the prior knowledge of the primary user. It is known that the energy of the signal to be detected is always higher than the energy of the noise. It is performed by comparing the received energy of the signal against a predefined energy detection threshold to determine the presence or absence of the user in the frequency band of interest. The major drawback of this technique is that it obstructs discrimination between sources of received energy namely interference from other cognitive radios and primary signal. The implementation and computational complexity are relatively low, and has bad performance under low signal to noise ratio (SNR) regions.

2) Matched Filtering

It is a coherent non-blind signal detection method i.e., it requires the prior knowledge of the primary user and

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cognitive radios to be equipped with timing devices and carrier synchronization. Its implementation complexities are high. SNR is maximized in the presence of additive noise hence, it is an optimum method. Matched filter detects the presence of the primary user by correlating the signal with the time shifted version and comparing the output with the pre-determined threshold.

3) Cyclostationary Feature Detection

Modulated signals are in general coupled with sine wave carriers, pulse trains, repeating spreading, hopping sequences, or cyclic prefixes, which result in built-in periodicity. Even though the data is stationary random process, these modulated signals are characterized as Cyclostationary since they exhibit periodicity. Cyclostationary feature detection is based on this principle. It requires partial prior knowledge of the primary user. It can also differentiate between different types of primary users by using their cyclostationary features. But implementation and computational cost is relatively high.

Ahypothesized model for transmitter detection is defined as that is, the signal detected by the Secondary user (SU) is:

- x(t): input signal;
- H0:Primary user is absent
- H1: Primary user is Present

Where H0 represents the hypothesis corresponding to "no signal transmitted", and H1to "signal transmitted", x(t) is transmitted signal.

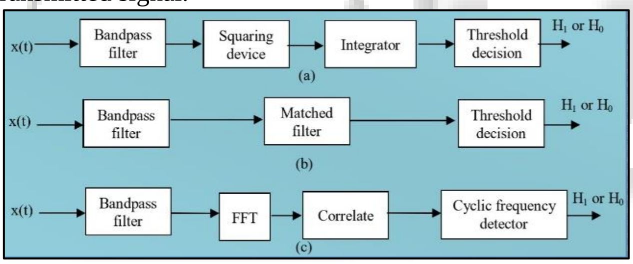

Fig 1: Block Diagrams For: A) Energy Detection; B) Matched filtering; C) Cyclostationary Feature Detection

B. WIDEB & Spectrum Sensing

Wideband spectrum sensing methods determine spectral opportunities for secondary users over wide range of frequencies. For example, determining spectral opportunities in the whole ultra-high frequency i.e., TV and mobile band, between 300 MHz to 3GHz, is possible with wideband spectrum sensing. Narrowband spectrum sensing makes single decision, impeding identification of individual spectrum opportunities, so detect multiple spectral opportunities wideband spectrum sensing is used. Types of Wideband spectrum sensing: Nyquist wideband sensing and sub-Nyquist wideband sensing.

1) Nyquist Wideband Sensing

Nyquist wideband sensing s based on sampling of the signal in the frequency band of interest at Nyquistrate. Wideband signal is obtained using a standard ADC and then digital signal processing techniques are used to detect spectral opportunities. The major drawback of this technique is high sampling rate and implementation complexity. The wideband signal x(t) is first sampled by a standard ADC at or above the Nyquist rate, after which a serial-to-parallel conversion circuit (S/P) is used to divide sampled data into parallel data streams. The time domain signal obtained is converted into frequency domain using Fast Fourier transform (FFT). The wideband spectrum X (f) is then divided into a series of narrowband spectra X1(f)…..XM (f). Finally, spectral opportunities are detected, where H0 denotes the absence of primary users and H1 denotes the presence of primary users.

2) Sub-Nyquist Wideband Sensing

In order to overcome high sampling rate in Nyquist wide band sensing Sub-Nyquist sensing is used. It is also known as compressive sensing or compressive sampling (CS), which recovers a signal from the samples, at a lower rate than the Nyquist rate. Sparsity of the signals of interest and incoherence of the sensing modality are the two principles of compressive sampling. CS becomes a promising technique to realize wideband spectrum sensing by using sub-Nyquist sampling rates and reduce burden on the ADCs, as the wideband spectrum is inherently sparse due to the low percentage of spectrum occupancy.

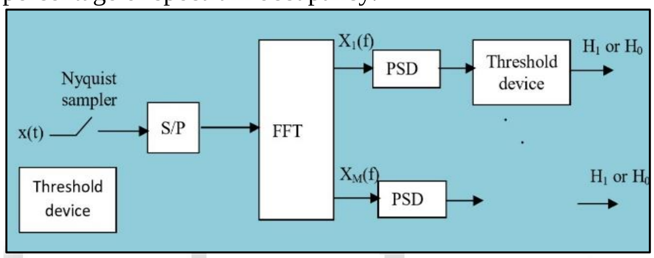

Fig 2: Block Diagram for Nyquist Wideband Sensing

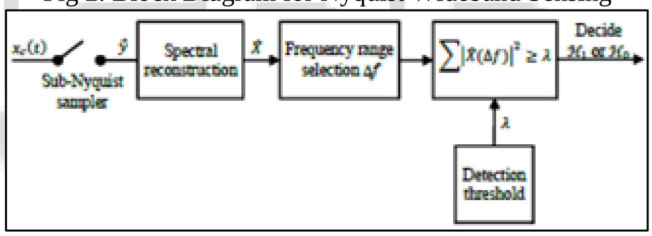

Fig 3: Block diagram for Sub-Nyquist wideband sensing

C. Comparison of Different Spectrum Sensing Techniques

Spectrum sensing techniques	Advantages	Disadvantages
Energy detection	Easy to implement. Low computational cost. Does not require prior information of the primary user.	Poor performance for low SNR. Cannot differentiate users.
Matched filtering	Optimal performance. Low computational cost.	Requires prior information of the primary user.
Cyclostationary feature detection	Valid in low SNR region Robust against interference	Requires prior information of the primary user. High computational cost.

	Nyquist wideband sensing	Sub-Nyquist wideband sensing
Advantages	Simple structure	Low sampling rate Signal acquisition cost
Disadvantages	High sampling rate Energy cost	Sensitive to design imperfections
Challenges	Reduce sampling rate Save energy	Improve robustness to design imperfections

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III. FUTURE SCOPE

Risks are inherent in wireless technology. Most significant source of risks in wireless networks is that the technology's underlying communication medium, the airwave, is open to intruders. Due to this reason a lot of efforts have been put to address security issues in wireless networks.

The advantage of quantum cryptography over traditional key exchange methods is that the exchange of information can be shown to be secure in a very strong sense, without making assumptions about the intractability of certain mathematical problems. Quantum cryptography exploits the fundamental laws of quantum physics where nobody can measure a state of an arbitrary polarized photon carrying information without introducing disturbances. The Quantum key distribution happens in two stages, in terms of concepts. It is noted that in Figure 3 the Wi-Fi connections are classical channels and the "optical Fiber" channels are quantum channels.

1) Stage 1: Quantum Channel (one way communication)

This transmission could happen in either through free space or optical fiber. At present this implementation is being done at the Lab.

2) Stage 2: Classical Channel (two way communication)

This phase deals with recovering identical secrete keys at both ends. Then photons are combined and sent into a fiber through a non-polarizing beam splitter (NPBS). The polarizers Pol. 0A, 0B, 1A, and 1B are oriented to 0°, 90°, +45°, and -45° respectively. Only two channels, 0A and 1A, are used for B92, while all four channels are used for BB84. At Bob, polarization controllers recover the polarization state of photons to their original state at Alice. The 3-dB coupler randomly chooses the detection base and the polarization beam splitter (PBS) helps to determine the key value via an agent-oriented. Finally the photons are detected by single photon detectors.

IV. CONCLUSION

Cognitive radio is a systematic approach that basically enhances the efficient utilization of the radio spectrum. In this paper an analysis of different spectrum sensing techniques in cognitive radio is presented. This provides accuracy in signal detection in less sensing time. The important potential advantages introduced by cognitive radio are improving utilization of spectrum and increasing QoS. Cyclostationary feature detection shows the better detection in narrow band sensing techniques, Sub-Nyquist is better in Wide band sensing. Improved Security using Quantum Key Distribution is also discussed.

REFERENCES

[1] Nasser, A. Mansour, K. C. Yao, H. Charara, M. Chaitou, "Efficient Spectrum Sensing approaches based on waveform detection," IEEE, 2014.

[2] Purbasha Datta, Khushbu, Prabir Banerjee, "Spectrum Sensing Techniques Applied in Cognitive Radio Networks," Volume 6, Issue 4, 2017.

[3] F. Salahdine, N. Kaabouch, and H. El Ghazi, "A Real Time Spectrum Scanning Technique based on Compressive Sensing for Cognitive Radio Networks," The 8th IEEE Annual Ubiquitous Computing, Electronics & Mobile Commun. Conf., pp. 1-6, 2017.

[4] H. Bennett, G. Brassard, "Quantum cryptography: Public key distribution and coin tossing", Proceedings of IEEE International Conference on Computers Systems and Signal Processing Bangalore India, pp. 175-179, 1984.

[5] Marcin Niemiec and Andrzej R. Pach, The measure of security in quantum cryptography, IEEE Global Communications Conference (GLOBECOM), 967-972, 2012.

[6] Hitesh Singh, D.L. Gupta, A.K Singh, "Quantum Key Distribution Protocols: A Review," Volume 16, Issue 2, Ver. XI, Mar-Apr. 2014.

[7] Mansi Subhedar, Gajanan Birajdar, "SPECTRUM SENSING TECHNIQUES IN COGNITIVE RADIO NETWORKS: A SURVEY", IJNGN Vol.3, No.2, June 2011.

[8] Moslem Rashidi, Kasra Haghighi, Arash Owrang, Mats Viberg, "A Wideband spectrum sensing method for cognitive radio using Sub-Nyquist sampling" Digital Signal Processing Workshop and IEEE Signal Processing Education Workshop (DSP/SPE), 2011 IEEE.

[9] Prachi Kumari, "Spectrum Sensing Techniques for Cognitive Radio Networks: A Review" IJ IRCCE Vol. 4, Issue 3, March 2016.

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