

SPECTRUM SENSING IN COGNITIVE RADIO

Vinod H. Patil¹, Palash Doshi², Sudarshan Dhomeja³, Sonali Thakur⁴

Dept. of Electronics and Telecommunication, Bharati Vidyapeeth Deemed University College of Engineering, Pune

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Abstract - Cognitive radio is the “intelligent radio” that provides increased bandwidth to mobile users by using dynamic spectrum access technique without compromising the licensed band allotted to every organization. It is software defined radio. Cognitive radio faces many challenges because of fluctuating nature of available spectrum as well as distinct Quality of Service required by different applications. Cognitive radio helps to identify the spectrum which is unused. The idea behind this article is to develop an understanding and discuss about the idea of Cognitive Radio.[1] Various spectrum sensing techniques are discussed in this paper.

1. INTRODUCTION

Keeping the need of consumers in mind and reduction in data cost, increasing the efficiency and interest in wireless communication system, the demand of cognitive radio has increased drastically. Every operator is provided with a distinct licensed band within which they operate in a certain band of frequency. However, many spectrum bands have already been assigned to many operators, so it becomes a bit difficult to identify the vacant band or even switch the already existing one.

Cognitive radio solves the problem of congestion which arises due to over usage of spectrum and provides higher data rate transmission and reception.[2] There are number of ways in which available spectrum band can be exploited.

	Analog TV	Digital TV	Wireless mics
Sensitivity	-94dBm	-116dBm	-107dBm
SNR	1Db	-21dB	-12dB

Table 1. Receiver’s sensitivity Requirement

Cognitive radio focuses on its ability to measure and sense the physical attributes of radio channel characteristics. This characteristics comprises of available n/w, nodes, policies, and various restrictions during operation. There are basically two types of users that exist in a cognitive network –

1. Primary users
2. Secondary users

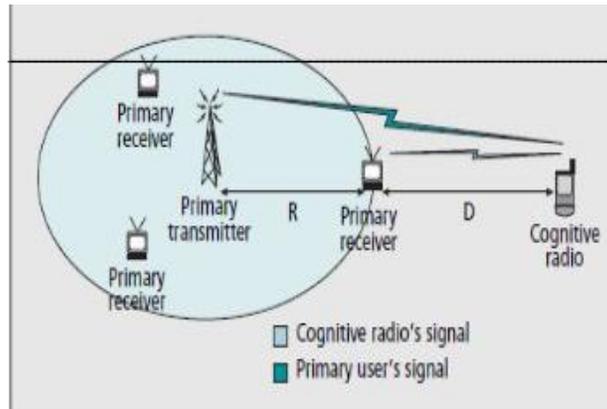


Figure 1. Interference range of a cognitive radio.

Primary users are the ones those who have higher priority or legal rights in the utilization of desired part of frequency band in spectrum. While, *secondary users* are those who have low priority. These secondary users penetrate and change the spectrum bands without interfering the primary users [3].

There may be some unfavourable effects on primary users caused by secondary user's interference. Also time, space and white spaces must be properly identified. Secondary user is given information of all the usage. It is done by uploading all the information on the main centralized database or transmitting this information on the regional beacons.

2. Methods of Spectrum Sensing

Primary signal can be detected by energy detection method. The energy that is received in primary bands can be analyzed by energy detection technique [4]. The white spaces are also declared if the analyzed energy is less then the threshold energy.

There is another technique for spectrum sensing, matched filter method. The matched filter method is comparatively faster than energy detection technique in term of sensing signals. But the drawback of energy detection method is that it is not possible to detect different types of received energy sources i.e. primary signals and noise.

When in practical use, different sensing techniques are combined for different situations. For example energy detection technique may be used for scanning a signal, even though its quite rough but to discover the white spaces in the band, other accurate feature detection techniques are used. To increase the efficiency of spectrum sensing, the gain of signal processing must be increased.

3. Sensitivity of detected signal

Cognitive radio network may undergo interference, which harm the network if it causes SIR (Signal-to-interference ratio) at receiver of primary system[5].

Characteristics of signals i.e. waveform of a signal, continous interference etc. may tamper with transmitted signal's waveform in some licensed bands.

4. Corporative spectrum sensing

When a network of cognitive radio share the information of sensing they gain, this term is coined as corporative sensing of spectrum. Due to various problems such as fading of signal, shadowing of signal, noise uncertainty, corporation of spectrum sensing was brought in light.

Problems such as mis-detection, false alarm consideration are decreased because of corporative spectrum sensing. Nevertheless corporative spectrum sensing cure many problems of hidden primary user and also minimizes the sensing time[6].

Corporative sensing face various challenges which comprises of developing efficient information sharing algorithm and also complexity is increased.

5. CHALLENGES

For sensing of spectrum in cognitive radio various challenges are associated that effect the working and functioning of cognitive radio. Some of those challenges are given below along with the measures taken to overcome them.

5.1 USE OF HARWARE

Cognitive radio designed will be efficient and feasible if it is able to analyze and detect signals for a larger band and thus this requires various extra components such as antennas as well as power amplifier etc.

5.2 UNDETECTED PRIMARY SYSTEM PROBLEM

When primary user is being scanned, various problems like multiple fading and overshadowing might be included. Unwanted interference is caused by primary system to cognitive radio which is due to different location of devices. This problem can be solved by corporate spectrum sensing method.

5.3 SENSING OF FREQUENCY

In cognitive radio, when a secondary user is operating on a particular band, the primary user has the authenticity to claim their frequency band anytime. Thus, secondary user have to vacate that band of frequency they are operating in. So proper parameters must be selected and determined during execution of cognitive radio.

5.4 SECURITY

In cognitive radio, various fraud users can alter the air interface or even mimic primary user. This fraudulent may harm the spectrum sensing which is performed by primary licensed users. Thus to overcome this, primary users are provided with a cipherd value or signature during transmission which is generated using a private key.

5.5 RELIABILITY

The data is transmitted to centralized command station continuously and with consistency, so the data transmitted must be reliable and also command center must be equally reliable.

5.6 SCALABILITY

When transmitting data at the centralized station, large number of parameters should be supported keeping in consideration that it does not hamper with the performance of system. Parameters such as nodes, traffic load etc. should be checked. Storage problem and limited processing of radio devices are also of great concern.

5.7 SIMULATION AND RESULT

For sensing of spectrum, an algorithm is created on LabView software which will give us the visual, graphical representation of the spectrum that is being sensed and also the noise present in that particular band of frequency. Hardware to be used is Universal Software Radio Peripheral (USRP). The device used for simulating the result is USRP-2901, which is a tunable RF transceiver. It is full duplex which provides bus-powered connectivity with USB 3.0 or USB 2.0. Other specification of USRP-2901 are that it is used for white space, to broadcast FM, sensor networks or GPS

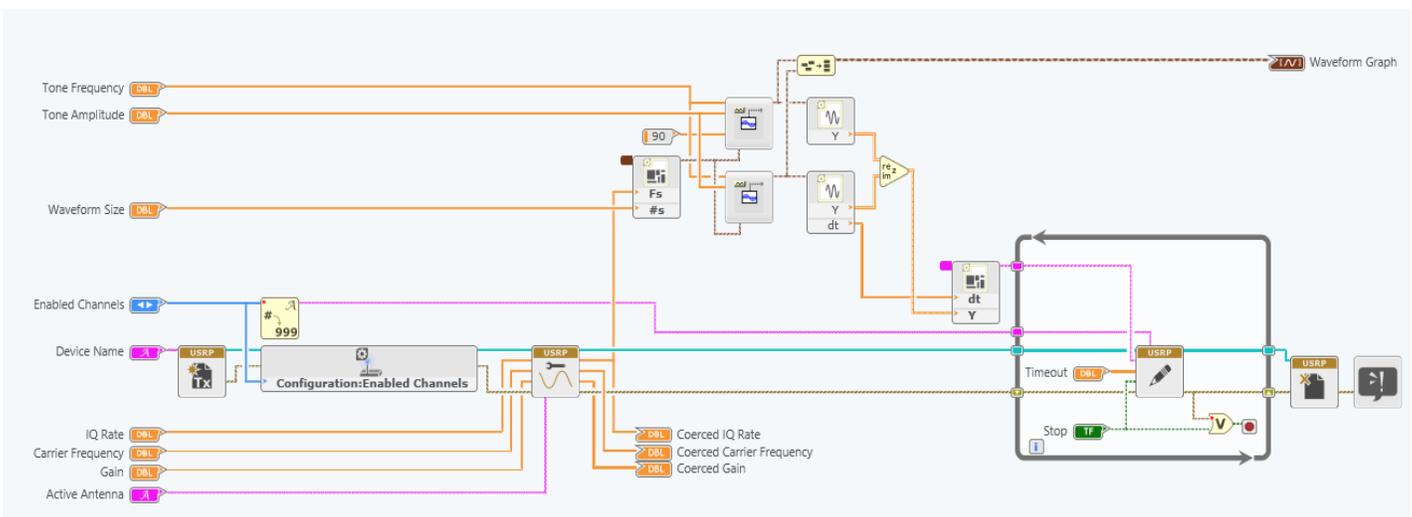


Figure 1. Block diagram for transmitting signal using LabView Software.

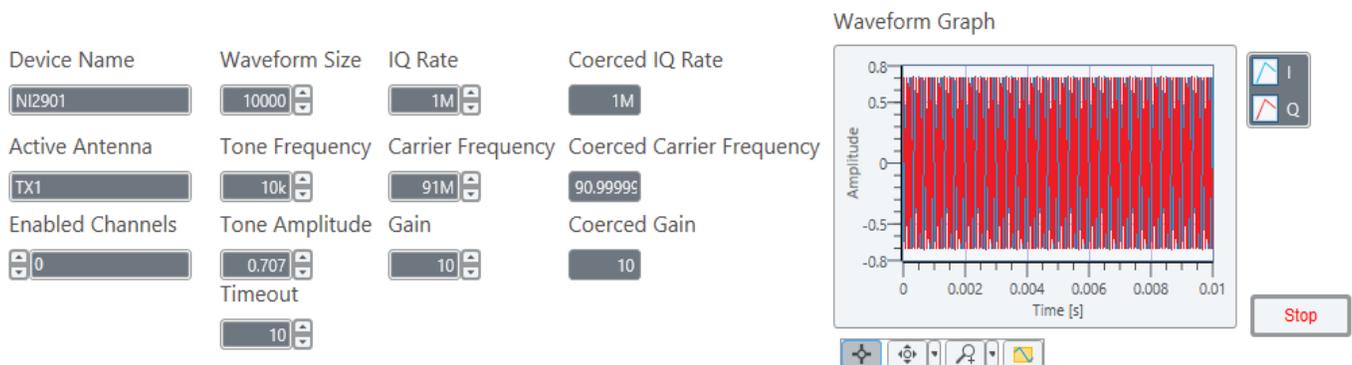


Figure 2. Graphical representation of transmitted signal.

Figure 1 shows the block diagram for transmitting the signal on USRP-2901 using LabView software for its sensing. The signal is transmitted at 91MHz of frequency with a gain of 10. The transmitted signal is to be sensed at the receiving end of USRP. Out of two antennas on USRP, the active antenna is set to TX1 for transmitting the signal.

Figure 2 shows the graphical representation of the signal that is being transmitted. It also contains noise in it. The device name is NI2901 which is the USRP that is being used for transmission through transmitting antenna.

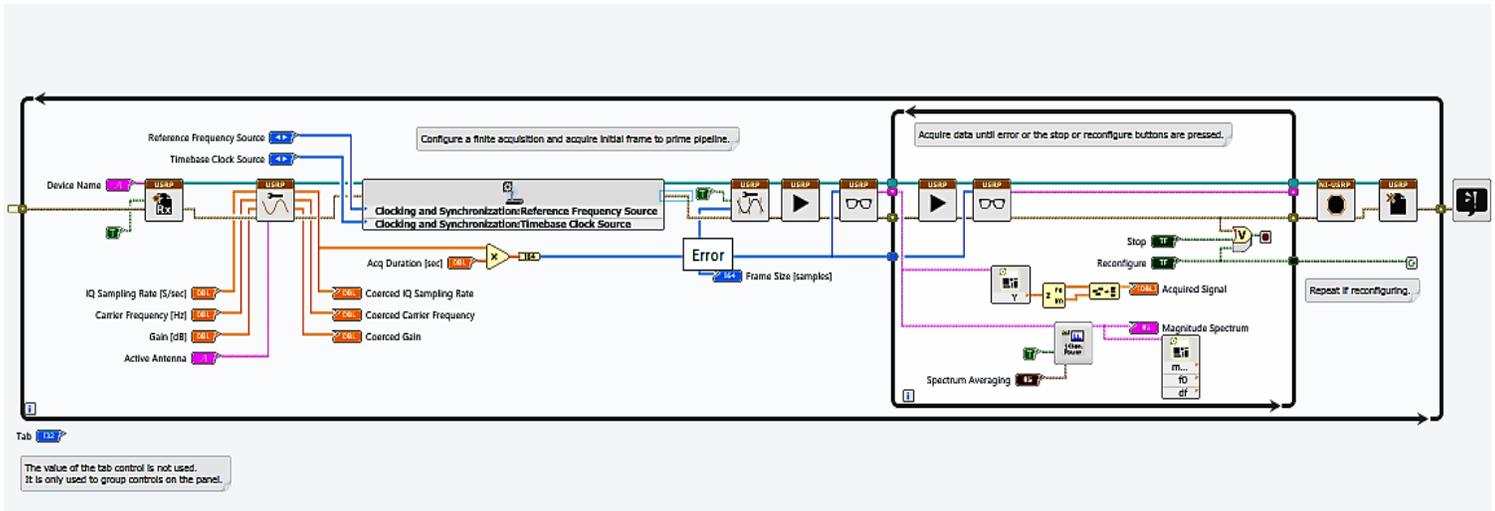


Figure 3. Block diagram for sensing the transmitted signal.

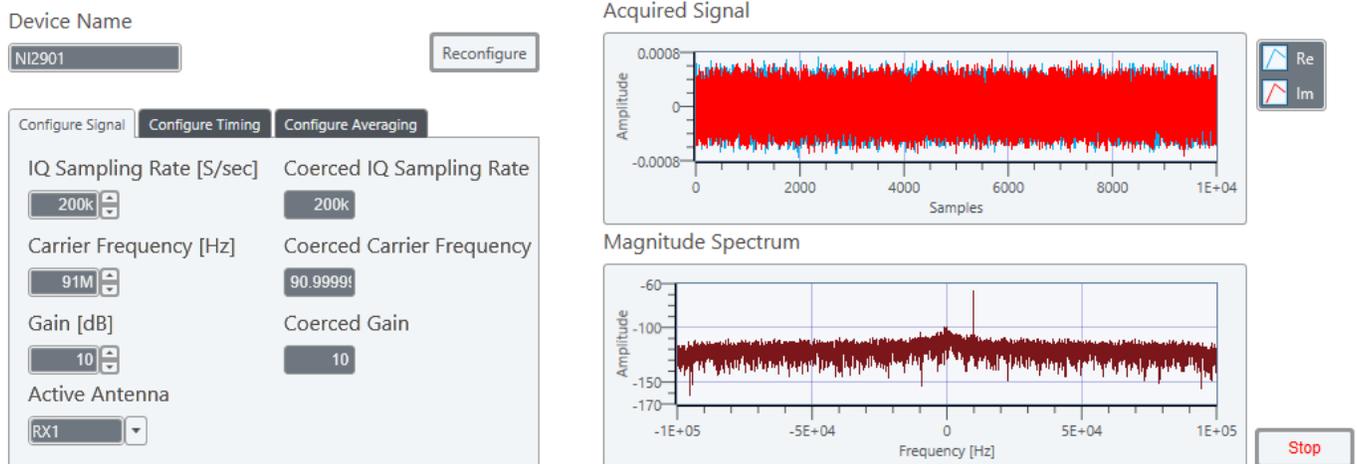


Figure 4. Graphical representation of sensed signal

Figure 3 represents the block diagram designed in LabView software for sensing of signal. The signal that is transmitted by the transmitter in figure 2, will be sensed here.

Figure 4 shows the graphical representation of the transmitted signal that is sensed. For instance, the signal was sent at the frequency of 91MHz from the transmitter, the same signal is sensed or detected in the figure 4. At a frequency of 91MHz, a peak occurs, which is the sensed signal as desired. This may contain some noise, which can be removed by the use of various filters.

6. CONCLUSION

In today's era of increasing wireless communication techniques, there is a great demand for radio spectrum. As the demand is increasing there is shortage of available licensed spectrum, thus congestion. So to overcome this problem Cognitive Radio is used. It is the intelligent radio, that uses the empty, available spectrum, thus creating a dynamic spectrum for all the users, without interfering with the licensed users or primary users. The spectrum sensing, senses the under utilized or vacant spectrum available and helps to ease the data transfer rate, maintaining the QoS i.e. Quality of Service. In this paper spectrum sensing concepts are seen, various sensing techniques and challenges were discussed.

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