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# Spectrum Sensing using Energy Detection Algorithm for Cognitive Radio

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**ABSTRACT:** *Spectrum sensing problems are increasing day by day which is due to the increase in use of cognitive radio. Cognitive radio is one of the emerging technologies, which increases efficiency and effectiveness of spectrum usage. In this paper, we will detect the presence of primary user with the help of Universal Software Radio Peripheral. We are using energy detection technique to sense the presence of signal on the spectrum. It will avoid the effect due to the presence of the secondary user.*

**KEYWORDS:** Cognitive radio, Spectrum sensing, Energy detection, USRP, LabVIEW.

## 1. INTRODUCTION

When a transceiver intelligently detects the different communication channels and allocate to secondary users simultaneously, that form of wireless communication is known as Cognitive Radio. The RF spectrum, which is available in the channel is used by decreasing the interference to other users. CR is a radio that detects the environment, which is electromagnetic and can secretly adjust its parameters to modify the whole system operation. It includes mitigate interference, facilitate interoperability and maximize throughput. Cognitive radio works as a transceiver, which determines the geographic location, identify and authorize its user, sense neighboring wireless devices in operation and adjust output power and modulation characteristics.

Cognitive Radio consists of two types of users, primary users and secondary users. Licensed users, which have higher priority over a specific part of spectrum, are known as primary users. Unlicensed users, which have lower priority over spectrum usage are known as secondary users. The spectrum is exploited by the secondary users so as to stop the interference caused by them to primary users. Hence secondary users have cognitive radio capabilities which help to detect that the spectrum is occupied by primary users or not. In cognitive radio there is a basic cognitive cycle which consists of three basic tasks: Spectrum sensing, Spectrum analysis and Spectrum decision making. Cognitive radio has also been in other fields like Public safety, Emergency network and Disaster management.

## 2. LABVIEW

LABORATORY VIRTUAL ENGINEERING WORKBENCH is a system-design platform for a visual programming language from National Instruments. "G" is its graphical language. Usage of LabVIEW is increased nowadays. It is mainly used for Instrument control, Data acquisition and Industrial automation. It can be worked on various operating systems like Microsoft windows, Unix, Linux, macOS. The programming language used, "G", is a dataflow programming language. In LabVIEW the execution is done with the help of graphical block diagram on which the programmer connects various function nodes. It is made by drawing wires which propagate variables and as soon as all input data becomes available, any node can execute the program.

## 3. USRP NI 2901

Term USRP stands for Universal Software Radio peripherals, USRP 2901 is a software programmable radio transceiver which is designed for teaching and research. It is helpful in the implementation of in the Industry's based wireless operation prototypes. Hardware of USRP is a device to utilize RF platform, it has the ability to transmit and receive signals for a wide frequency range and it also provide MIMO support. It enhances the platform, which are used for graphical programming such as labVIEW.

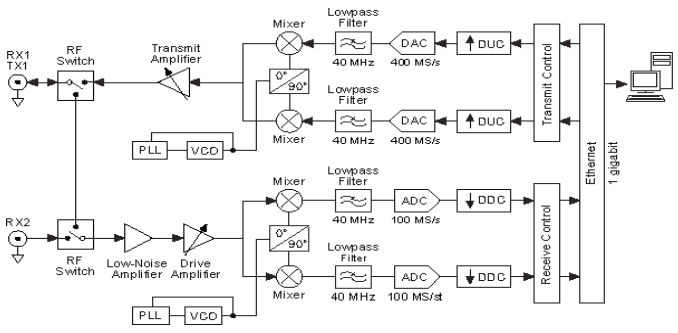


**Fig -1**: Hardware architecture of NI-USRP

**For Transmission**, The USRP hardware interpolates the incoming signal to a higher sampling rate using a digital up conversion (DUC) and then converts the signal to analog with a digital-to- analog convertor (DAC). The resulting analog signal is mixed with a carrier frequency. The phase-locked-loop is used to control Voltage-Control-Oscillator (VCO). Transmit Amplifier amplify the signal and then transmitted with the help of antenna. **For Receiver**, Low noise amplifies and drive amplifier amplifies the signal and mixer converts the signal into Baseband in-phase and Quadrature phase signal, then ADC convert the signal into digital form and Digital down converter (DDC) is used to provide user specified rate.

## 4. SENSING OF SPECTRUM

This sensing is more generic as knowledge on the primary user's signal is not needed by the receiver. To detect the signal, the comparison of the output of the energy detector and threshold which depends on the noise floor is done [64]. This technique faced some common problem such as level of noise floor, threshold level for primary users, ability to detect interference for noise and primary users. In addition, if we consider low signal to noise ratio, then performance of this technique is poor.

Let's assume this as a simple form of received signals

$$Z(n)=X(n) + W\ (n) \qquad \text{- (i)}$$

Where, X(n) is actual signal going to detect and W(n) is AWGN.

If X(n)=0, it means primary user is not using a particular spectrum which will be utilized by the secondary user.

Energy of the received signal

$$Z= \sum_{n=0}^{N} |(n)|^2 \qquad \text{-(ii)}$$

This equation is also called decision matrix. So, the energy level Z will be compared with the noise threshold $\gamma_n$. This noise is fix.

So, they use two cases:-

$$H_o : Z(n) = W(n) \qquad \text{-(A)}$$

$$H_1 : Z(n) + W(n) \qquad \text{-(B)}$$

In case A where the primary user is not present while in case B primary user is present. For detection of availability of a signal there are two probability $P_d$ and Pf, which are probability of detection of a signal when it is actually present, is separated by $P_d$ and probability of detection of signal when it is not present is called false alarm, is separated by $P_F$. It can be expressed as

$$P_D = P_R(Z > \gamma_N / H_1) \qquad \text{-(iii)}$$

$$P_F = P_R(Z > \gamma_N / H_0) \qquad \text{-(iv)}$$

So factor $P_F$ play an important role in energy detection technique. Therefore, underutilization of the available spectrum can be prevented by maintaining the value of $P_F$ as small as possible.

## 5. RESULT

### 5.1 Concept of Sensing

We have designed a code to sense the presence of primary user. We are performing Power Spectral Density (PSD) operation of time signal by using PSD block. This block returns the average power spectrum or power spectral density and the frequency scale, magnitude of the power spectral density has the units of the input signal unit – rms square per hertz for power spectral density and unit rms square for power spectrum. We are comparing the magnitude of the output signal produced by the psd block with a threshold value.

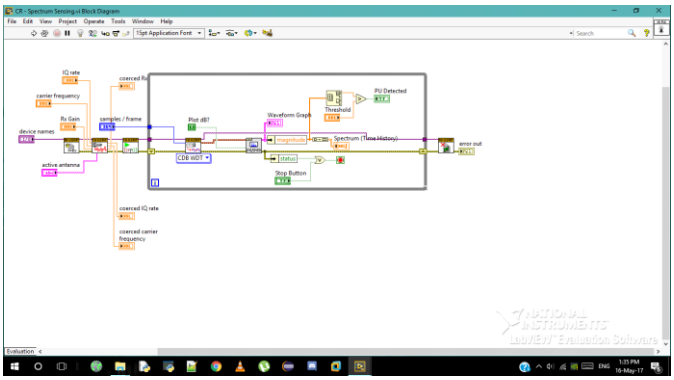

**Fig -2**: Design of block

### 5.2 While there is no primary user

In the absence of primary user the magnitude of PSD will be less than the threshold value. In this case only noise signal is present. As we can see in this figure there is no frequency response and the amplitude is very low.

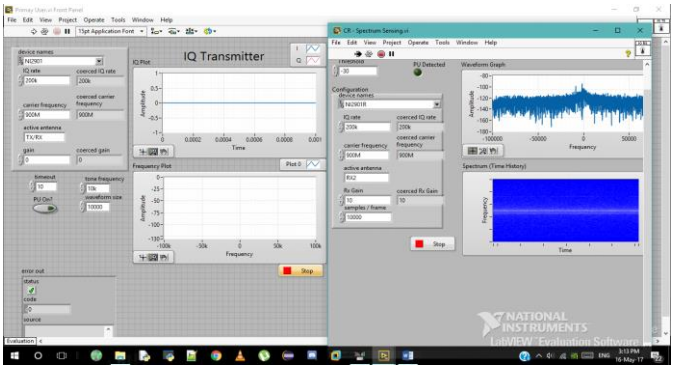


**Fig -3**: PU is absent

### 5.3 When primary user is present

In this case we will receive a frequency response of received signal. After performing the PSD operation of this signal we can see that the amplitude is higher in this case and this is greater than the threshold value. Therefore, after comparing these two values (Amplitude of PSD and Threshold), LED will glow because of the lower value of threshold and this will alert that the primary user is present.

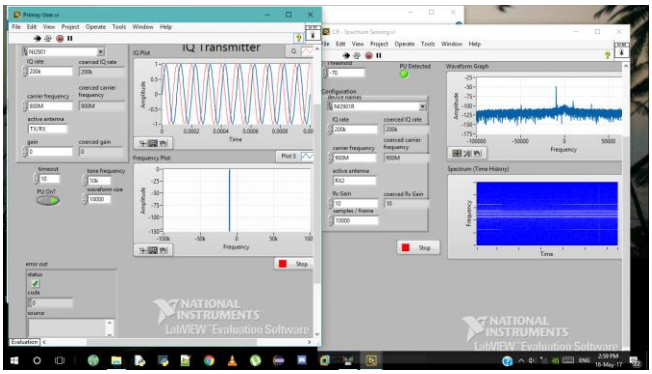


**Fig -4**: PU is present

## 6. CONCLUSION

In this paper we have sensed the presence of primary user. We have used energy detection technique to detect the spectrum. We have used LabVIEW platform and NI-USRP 2901 tool kit and designed the required model. We have placed two USRP NI 2901 kits on different distances and as we know that threshold value are affected due to different factors such as Geographical Conditions, Transmission Lines and some others. In this we have used hit and try values of Threshold.

In Cognitive Radio's operation spectrum sensing plays an important role. New interpretation of spectrum space will provide different opportunities in this area. As technology is changing day by day and there is no doubt that we will experience various technologies which will create more opportunities in this field and in coming years Cognitive Radio will be the key of future wireless communication/ telecom world.

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