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Spectrum Sensing Based On Cognitive Radio Networks

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Abstract: In wireless communication we deal with new emerging technologies. There is lack of radio spectrum because of large number of applications. Thus, spectrum utilization is very important issue nowadays. In order to utilize the radio spectrum and increase the efficiency of the wireless communication system we need to design a compact system. Cognitive radio is used to improve the efficiency of radio spectrum resources. The aim of this project is used to create software used for spectrum sensing. It uses MATLAB software for coding of various spectrum sensing techniques. The software consists of following spectrum sensing techniques like Transmitter detection and interference based sensing.
Keywords: MATLAB, Spectrum Sensing, Cooperative, Non-Cooperative.

I. Introduction

In today's world, the need for wireless communication is increasing day by day. As a result of newly emerging technologies and wireless applications, the demand for radio spectrum also increases. But the frequency spectrum is limited which leads to scarcity of radio spectrum. Currently, Spectrum allocation is done using static allocation where each new user is provided with its own fixed frequency band. With, most of the primary spectrum already allocated, so it has become difficult to find vacant spectrum for new users or to enhance existing services. Also, the conventional approach of spectrum allocation is inflexible because current government policy does not allow the unlicensed users to access the licensed spectrum, due to which there is a huge scarcity of spectrum band used by unlicensed users. In order to overcome this problem, we need to utilize the radio spectrum efficiently. Hence, the idea of Cognitive Radio was introduced.

Cognitive Radio helps to overcome the problem of spectrum underutilization in wireless communication. Cognitive radios are designed in order to use the spectrum efficiently and to provide reliable communication to all users of the network. It includes four main functional blocks: spectrum sensing, spectrum management, spectrum sharing and spectrum mobility. The architecture of Cognitive radio comprises of: primary user, secondary user, and shared channel. The unutilized licensed spectrum is shared between primary and secondary users. Secondary users have low priority in using the channel. Therefore, secondary users have to vacate the channel in a timely manner when the primary user is detected to avoid interference.

By detecting the presence of primary user, Spectrum sensing aims to enable the unlicensed user to determine the unutilized portion of the spectrum to be used. Spectrum management aims to select the best available channels based on user requirements. Spectrum sharing allows the access of the shared channel with other unlicensed users whereas spectrum mobility vacates the channel by shifting the secondary user to some other frequency channel when primary user is detected.

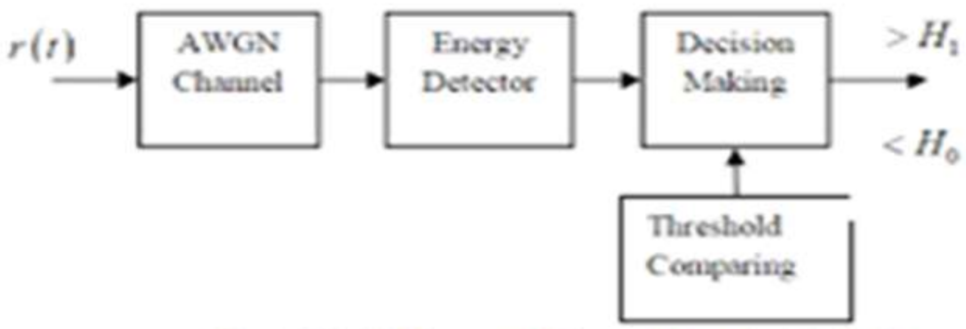

Fig. 1: Block Diagram of Energy Detection Technique

There are several different spectrum sensing techniques used in cognitive radio to obtain better performance. Spectrum sensing techniques can be classified into three types: primary transmitter detection, primary receiver detection and interference based detection. The aim of this paper is to implement different spectrum sensing techniques and compare them using different parameters.

II. Block Diagram

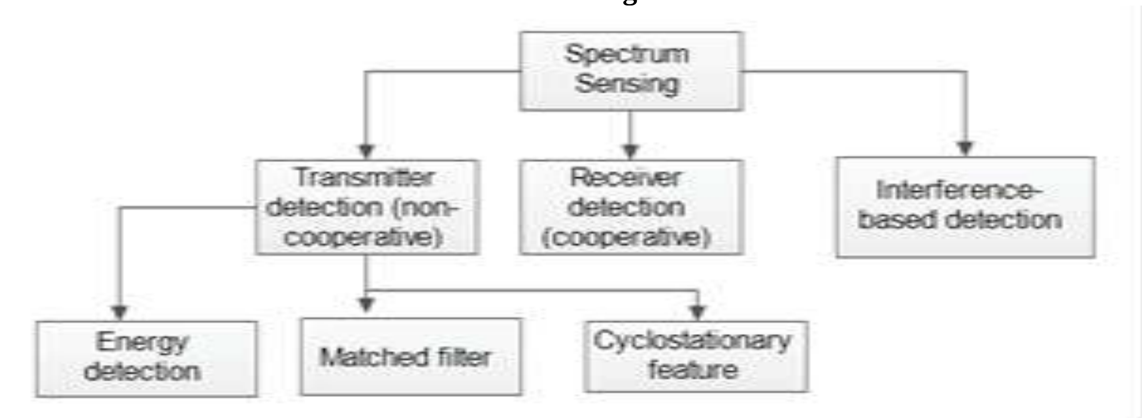

Fig.1Block diagram

II. BLOCK DIAGRAM DESCRIPTION

III.1. *A) SPECTRUM SENSING:*

Spectrum sensing enables the Cognitive Radio users to adapt to the environment by detecting spectrum holes (opportunities) without causing interference to the primary licensed users. This can be done through a real-time wideband spectrum sensing capability to detect weak primary signals in a wide spectrum range. After the spectrum holes have been identified then the Cognitive Radio users can utilize them for their transmission.

III.1. *B-1)TRANSMITTER DETECTION(NON-COOPERATIVE):*

Firstly, the primary user signal on which the different spectrum sensing approaches can be applied need to be generated in the side with different parameters such as: the operating frequency, the modulation scheme and, the sampling frequency. Then, to pass it through channel which also has specific characteristics such as: fading, noise etc.

III.1. *B-2) ENERGY DETECTION*:

Energy detection is a simple sensing technique, which does not need any information about the PU signal to work.This signal detection is quite convenient for implementing practically. To implement energy detector, noise variance information is needed. Incomplete knowledge of noise power may lead to the phenomenon called SNR wall, which is a SNR level beneath which the energy detector cannot reliably detect any signal which are transmitted even after increase in the observation time.

Fig.2Energy detection technique

III.1. *B-3) MATCHED FILTER DETECTION*:

Matched filter detector senses the SNR at the output and it maximizes the same. Pre knowledge about PU signals is needed to understand it as a optimal filter. This is a good technique when some information of PU signal is available at the SU receiver.

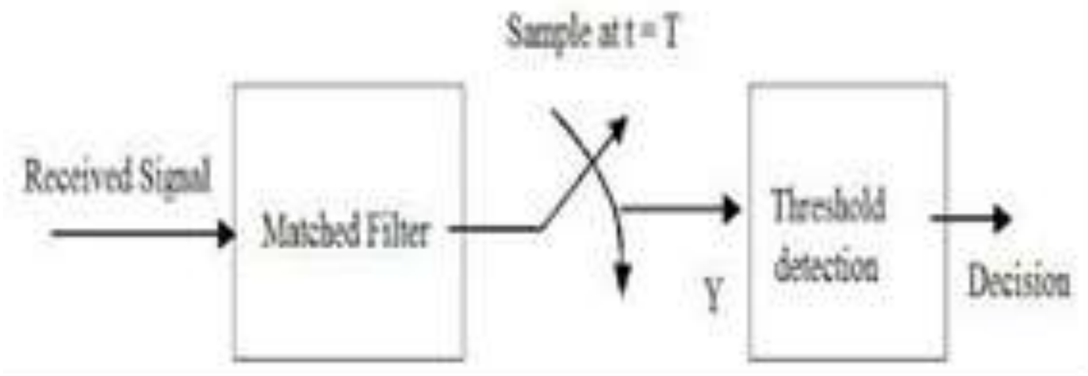

Fig.3Matched filter detection

III.1. ***B-4)CYCLOSTATIONARY FEATURE*****:**

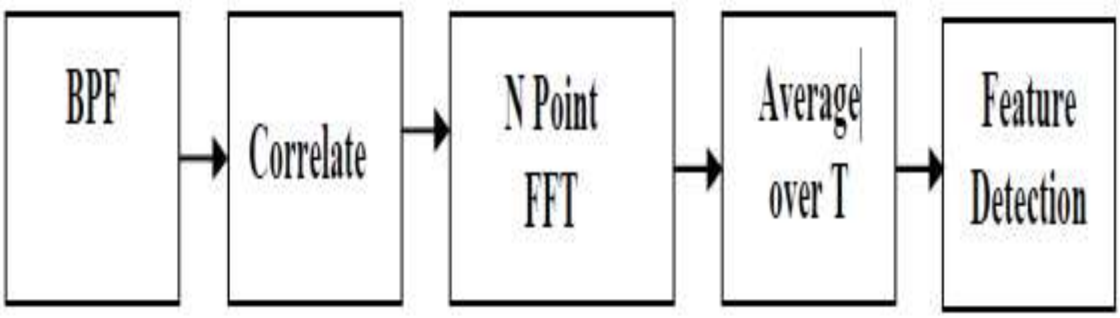

Fig.4Cyclostationary technique

The algorithm used in these spectrum sensing algorithms are motivated because most man-made communication signals such as BPSK, QPSK, AM, OFDM etc. exhibit cyclo-stationary behaviour. Noise signals (typically white noise) do not exhibit cyclo-stationary behaviour. These detectors are robust against noise variance uncertainty. The intention of such detectors is to exploit the cyclo-stationary nature of man-made communication signals buried in noise. Cyclo-stationary detectors can be either single cycle or multi cycle cyclo-stationary.

This technique is robust to noise discrimination and it performs better than energy detector and the matched filter under low SNR values. But, its disadvantages are: more computational complexity and longer time for sensing the spectrum.

III.1. ***C) RECEIVER DETECTION(COOPERATIVE):***

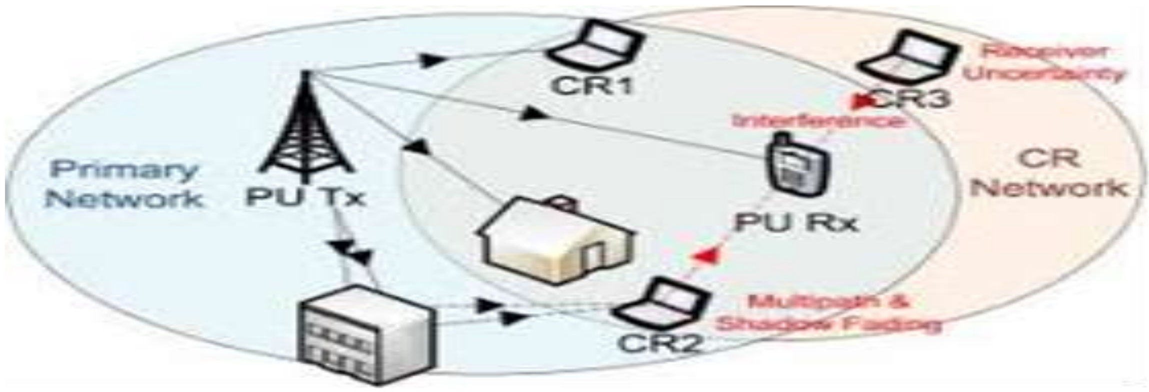

Fig.5Receiver detection

The main idea of cooperative receiver detection sensing is to enhance the sensing performance by exploiting the spatial diversity in the observations of spatially located CR users. Cooperative sensing allows SUs to cooperate and consolidate their spectrum sensing efforts in order to reach a more accurate conclusion about spectrum availability. Receiver detection approach of spectrum sensing comes as a solution to a major drawback of non-cooperative sensing, that is the effect of the hidden node problem on the sensing

III.1. ***D) INTERFERENCE BASE DETECTION*****:**

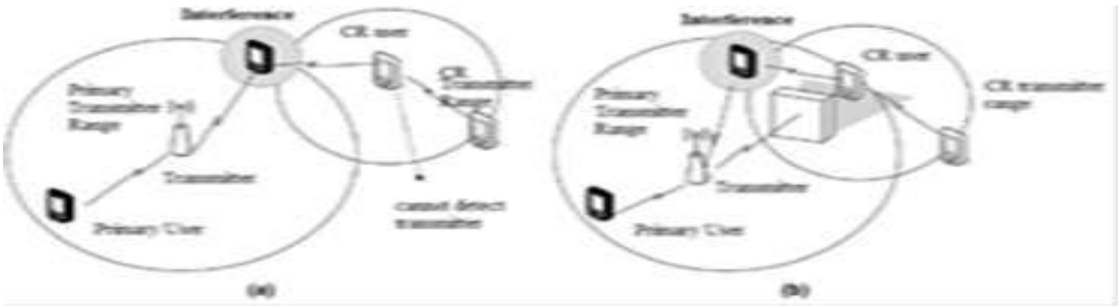

Fig.6Interference base detection

Interference is typically used in a transmitter-centric manner, which means interference can be controlled at the transmitter through the radiated power and the out of band emission and location of individual transmitter. However, interference detection actually takes place at the receivers as shown in figure.

There are two approaches for interference based detection technique to sense unoccupied spectrum in Cognitive Radio Networks:

1) Primary Receiver Detection.
2) Interference Temperature Model.

This paper explains these two interference based detection techniques.

IV. Project Progress

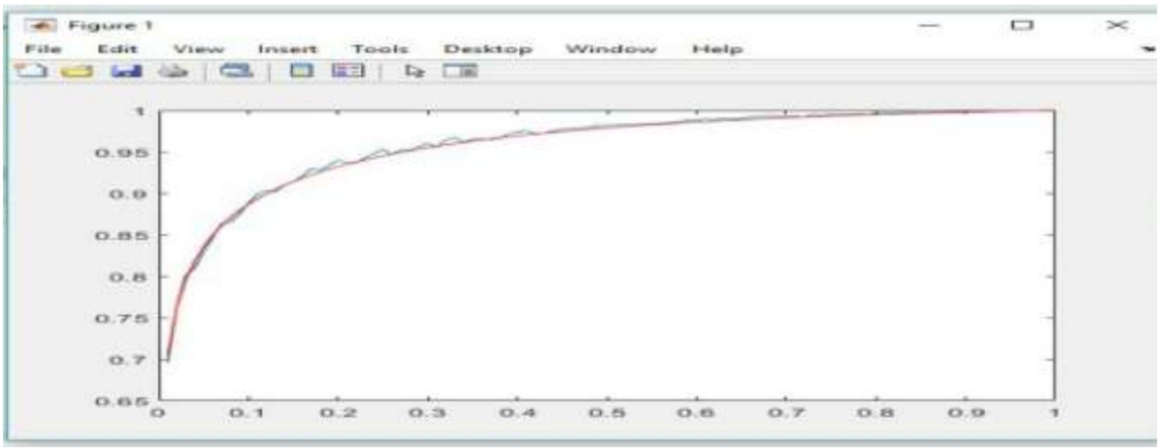

Fig.7Energy detection output

V. Applications

- It is used to determine unutilized spectrum of the licensed users.
- It improves the efficiency of radio spectrum.
- Applications of Cognitive radio networks to the military actions such as nuclear attack detection and investigation, command control, obtaining information of battle damage evaluations, battlefield surveillance, intelligence assistance, and targeting etc.
- The application of Cognitive Radio networks to emergency and public safety communications by utilizing white space.

VI. Conclusion

Hence we have started to implement different Spectrum sensing techniques based on cognitive radio network. It uses MATLAB software for codingof various spectrum sensing techniques and SIMULINK software for simulating the outputs in a graphical interface.

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