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A Review on Spectrum Sensing Techniques in Cognitive Radio

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Abstract: *Cognitive radio is a form of wireless communication which is used to utilize the underutilized spectrum. For utilizing the spectrum sensing is applied to detect the primary users if present .Cognitive Radio detects the presence and absence of primary users and use the spectrum only if the communication does not interfere with primary users. This Paper presents various spectrum sensing techniques of Cognitive Radio's and their pro's and con's. The idea of cognitive radio is generated to overcome the issues detected in spectrum usage and it provides wireless users in the given radio environment.*

Keywords: *Power Spectral Density(PSD),Signal to noise ratio (SNR),Cognitive Radio(CR).*

I. INTRODUCTION

In past years the desire for effective and flexible wireless communication is much in demand. As a result the future of wireless networks will be the combination of mobile communication systems and internet technologies that promise to offer a ample of services to its users.

Eventually, the spectrum licensing leads to spectrum scarcity and let frequency spectrum utilization unbalanced. One of solution to this problem is the Cognitive Radio. It has an intelligent layer that performs sensing of environmental parameters to achieve best performance in different situations. Spectrum sensing i.e. frequency spectrum for empty bands are checked in cognitive radio. Cognitive Radio is a technology that is proposed so that the frequency spectrum can be utilized efficiently. The formal definition for Cognitive Radio is given as [1]

"**Cognitive Radio is a radio for wireless communications in which either a network or a wireless node changes its transmission or reception parameters based on the interaction with the environment to communicate effectively without interfering with the licensed users**."

Federal Communications Commission (FCC) introduced Secondary and concurrent usage of spectrum. It is focused that secondary may not interfere the licensed users during their tasks. Cognitive Radio (CR) is a technology that has been built as it allow the access to the white spaces and vacant frequency bands.

II.SPECTRUM SENSING TECHNIQUES

There are different ways for signal detection and also CR users in the network[1]:

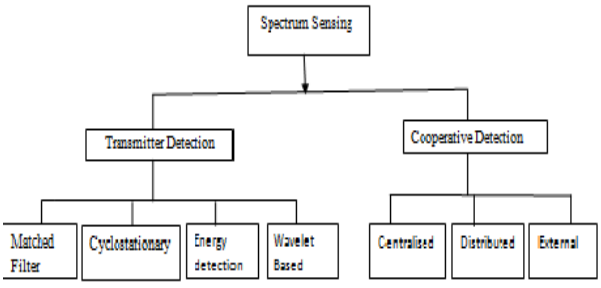

Fig 2.1 Sensing Techniques

MATCHED FILTERING

This technique is important in communication as it is maximizes the signal to noise ratio (SNR). It is a linear filter and prior knowledge of the primary user signal is very important for its operation. Power consumption and implementation complexity is large in this .The parameters required for matched filtering are modulation, packet format, pulse, frequency. As a result it will find spreading codes, preamble.

Pros:

- It maximizes the SNR.
- The sensing time is low as compared other techniques but greater than waveform based spectrum sensing.

Cons:

- It should have prior knowledge of the primary user signal.
- Computational complexity is high as compared to other sensing methods.
- It needs ample number of receivers and thus various algorithms need to be evaluated and So, the power consumption is high.

CYCLOSTATIONARY

Cyclostationary based sensing considers the periodicity property of signals. The signals which are used in various applications are generally combined with sinusoid carriers, cyclic prefix, spreading codes, pulse trains etc. Primary user signals which have these kind periodicities can be detected by taking their correlation. Fourier transform of the correlated signal results in peaks at frequencies which are specific to a signal and searching for these peaks helps in determining the presence of the primary user. Noise is random in nature and as such there are no such periodicities in it and thus it doesn't get highlighted on taking the correlation.

Pros:

- This technique works good in low SNR conditions.
- It has the capability to distinguish between primary user and noise.
- Differentiate between different types of signals.

Cons:

- In this, cyclic frequencies can be calculated that is why computational complexity is higher than energy detector.

ENERGY DETECTOR

This method of spectrum sensing is also known as period gram. This method is proposed to find the received energy through signals and also to calculate thresh hold value. The signal are detected when the noise floor and output signals are compared. Energy obtained greater than the threshold values tells that primary user is present in the network. A threshold value is needed for comparing the energy.
This approach has less implementation complexity and also low computational power. It perform poor due to low signal to noise ratio.

Pros:

- It doesn't require prior knowledge of the primary user's signal .
- The Computational and implementation complexity is low.

Cons:

- It Perform poor in low SNR conditions.
- It doesn't identify properly between primary users and noise.

WAVLET BASED

This method is mainly used for edge detection where user are present in narrower area[2]. This method is used to identify power spectral density over a large part of domain. The frequency band allocation is between 3GHz-10GHz in wavelet based sensing especially for ultra wideband sensing. It detects the underlying narrow user within it such as Wimax , wifi ,S-band satellite , C-band satellite.

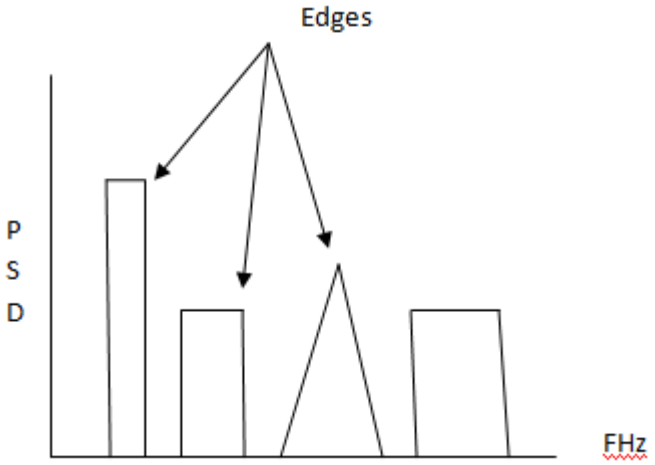

Fig2.2: Edge detection in narrowband using

Wavelet based sensing

Pro's

- Efficient method for detecting edges for narrowband users.

Con's

- High sampling rate required for operating at narrow edges.

III. COOPERATIVE DETECTION

Sensing is carried out by a number of different radios within a cognitive radio network in cooperative sensing. Cooperative sensing reduces interference between cognitive users where a certain issues such as shadowing ,multipath fading occurs because one cognitive radio may not be able to recognize primary user. but a another primary user acting as a receiver

may be able to recognize primary user and the cognitive radio signal.

Pro's

- Problem of hidden node is reduced.
- Reduced false alarms.
- Great performance in signal detection.
- Provides greater reliability.

CENTRALISED APPROACH

In this technique there is a master node is present in the network that collects the sensing information from all the sensing nodes .The results after scanning are collected at master node. The aim is to overcome the fading issues in the network and is to increase the performance of channel detection. The cognitive radio nodes that are trustworthy will be allowed to report their information to the central node.

Pro's

- Reduce the probability of miss detection

DISTRIBUTED APPROACH

In the distributed approach cognitive nodes among them distribute the information and make their decision that which node will take control. This approach is infrastructure less and require less implementation cost.

Pro's

- It requires no hardware
- Reduced cost
- Perform better than centralized approach

EXTERNAL SENSING

In this sensing, external agent performs sensing and then broadcast the sensed information of vacant channels. This method increases the spectrum efficiency because the cognitive nodes doesn't waste it times to sense the channel which external agents are doing. Thus it doesn't require a much power level and also it is not necessary that that the sensing environment should be mobile[5].

Pro's

- Less power consumption.
- Reduce shadowing and fading.

IV. CONCLUSION

Utilizing a spectrum is more necessary because spectrum is becoming scarce. Cognitive Radio provides capability of sensing the unused spectrum and to use it. In the past decade the demand of high speed communication has increased at a cost of reliability In this paper different spectrum sensing techniques has been discussed. Every technique has its own pro's and con's which are mentioned .Enhancing these techniques with reduced cost and overcome the failure's will be the further area of research in Cognitive Radio.

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