A Review on Spectrum Sensing Techniques in Cognitive Radio

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Abstract - ***In cognitive radios energy detection can be used for spectrum sensing. This paper presents review and literature survey related to cognitive radio based Wavelet Transform. Many researchers describe Performance evaluation of the energy detection using Haar wavelet for spectrum sensing in cognitive radio. The day to day upgrading technology in wireless communication have provides a lot of effort on the usage of the radio spectrum in the limited resources. This spectrum assignment method is some time inconvenient to utilize the available spectrum. The Cognitive radio is one of the intelligent technologies for converting static spectrum assignment to dynamic spectrum assignment. By this technology we can reduce the available hole to predict the spectrum resolving capacity. In these paper a comparative study is being taken we focuses on the utilization of the available spectrum sensing in cognitive radio techniques introduced till now, specifically based on wavelet transform.***

Keywords: Cognitive radio, Spectrum sensing, wavelet transform, Energy detection techniques.

I. INTRODUCTION

In the wireless communication system individually users are increases day by day, due to which the available resource are become limited in nature. Today the spectrum management is provided on the basis of the fixed frequency spectrum assignment which result under utilization of the frequency spectrum[1][2][3] .Similarly the conventional approach is also inconvenient method in which need licensed through which the spectrum management is very inflexible in the nature that each of the wireless operators assign a licensed frequency band , it become very difficult to understand vacant spectrum which is already allotted by wireless operators. In order to overcome the insufficient utilization of the radio spectrum,

Cognitive radio is new emerging technology in the wireless communication to facility the insufficient utilization of the radio spectrum, which consists of the primary and the secondary user. The primary user is a licensed user and the secondary user is unlicensed. In licensed or primary users, which has the highest priority for accessing the spectrum and secondary user is a unlicensed user for accessing the spectrum. The Cognitive radio play the vitral role for accessing the spectrum , so that the spectrum can utilizes easy on the bases of the leased nature .It work smartly for accessing the spectrum . To improve the efficiency cognitive radio uses several spectrum management methodologies.

The primary objectives of a cognitive radio are two folds:

• Efficient utilization of wireless spectrum

• Reliable communications without affecting primary users

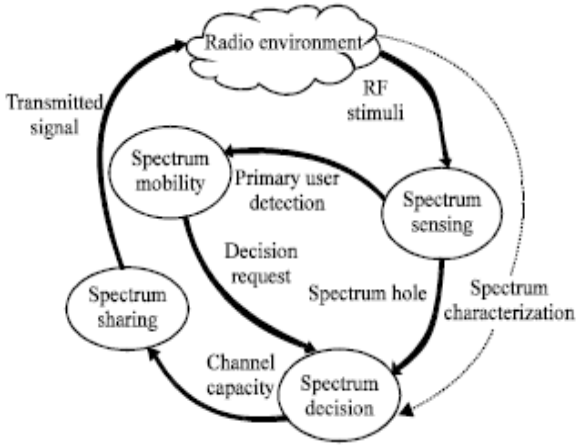

Figure1: Block diagram of cognitive cycle

II. SPECTRUM SENSING METHODOLOGY

There are four different method of cognitive radio in spectrum sensing technology that are spectrum management, spectrum sharing and spectrum mobility. Here the spectrum sensing is identify the presence of vacant spectrum in the surrounding environment i.e. vacant spectrum in those licensed bands .Spectrum Management is used to find out how long the secondary users can use those vacant spectrum .Spectrum Mobility is to maintain communication during the transition to better spectrum .Spectrum sharing it is provide the fair spectrum scheduling method among existing user .In this paper shows Comparison of different wavelet family that the probability of the detection Pd with SNR curves using different methods

III. MATCHED FILTER DETECTION

Matched filtering [4] is known as optimal method for detection of primary users when the transmitted signal is

known. It is a linear filter designed to maximize the output signal to noise ratio for given input signal. It is obtained by correlating a known signal, with an unknown signal to detect the presence of the known signal in the unknown signal. This is equivalent to convolving the unknown signal with a time-reversed version of the signal. Convolution is at the heart of matched filters. Convolution does essentially with two functions that it places one function over another function and outputs a single value suggesting a level of similarity, and then it moves the first function an infinitesimally small distance and finds another value .The end result comes in the form of a graph which peaks at the point where the two images are most similar [5]. The matched filter is the optimal linear filter for maximizing the signal to noise ratio (SNR) in the presence of additive white stochastic noise. Matched filtering requires cognitive radio to demodulate received signals. Hence it requires perfect knowledge of the primary users signalling features such as bandwidth, operating frequency, modulation type, pulse shaping and frame format. A matched filter compares two signals and outputs a function describing the places at which the two signals are most like one another. This is carried out by taking Fast Fourier Transform (FFT) of two signals, then multiplying their coefficients and after that taking Inverse Fast Fourier Transform (IFFT) of the result, the output can be find out .The few advantages are that it needs less time to achieve high processing gain and probability of false alarm and missed detection due to coherent detection and few disadvantage are that it would require a dedicated sensing receiver for all primary user signal types. It requires the prior information of primary user signal which is very difficult to be available at the CRs. It requires large power consumption as various receiver algorithms need to be executed for detection.

IV. ENERGY DETECTION METHODS

Energy detection is a non coherent detection technique in which no prior knowledge of pilot data is required. There are the following issues of the spectrum sensing [6], they are

1. Required sensing time to choice the desired goal between the probability of the detection and false alarm.
2. Limited or energy detector performance due to presence of noise uncertainty and back ground interference.
3. Performance improvements offered by network cooperation.

In this energy detection approach is used to determine whether the channel is occupied or not on the basis of the received signal strength Indicator (RSSI) i.e. RF signal energy is measured .Firstly, we select the bandwidth of the signal and then signal is filtered by the band pass filter. After getting the squared of the output signal, it is integrated over the interval of the time t. At the end, the output of the signal is compared with the threshold value i.e. whether the signal is above the threshold level signal is present or below the threshold level signal is absent .There are two hypothesis on the basis of test of the detection i.e. H0 and H1 [7][8].

$H_0 : y[n] = w[n];$ Signal is absent

$H_1 : y[n] = s[n] + w[n];$ Signal is absent, where n = 1, 2, 3

Energy of a function $f(x)$

$$energy = \frac{1}{2}\int_0^{2\pi} |f(x)|^2 dx$$

$$T(Y) = \tfrac{1}{N}\sum_{n=1}^{N}\{Y[n]\}^2$$

N= τ fs, Where N is the no of the sample available or τ sample size, fs is sampling frequency

Ty (N) > λ = Present of PU

Ty (N) < λ = Absent of PU

The decision can be given as: if Ty(N) > λ, signal exists; otherwise, signal does not exist.Interference, noise uncertainty and varying threshold under low SNR can limit its performance.

V. WAVEFORM-BASED DETECTION

It is a simplified version of matched filter detection in terms of knowledge of primary user's signal required. In this approach, the cognitive device does not need to demodulate the primary user's signal and thus the perfect knowledge of primary user's signal is not needed. Instead, it only requires knowledge of patterns such as pilots, preamble or synchronization words. The decision metric is adopted from matched filter detection [11].

$$S_r(f) = \sum_{n=1}^{\infty} \alpha_n^2 s_n(f) + s_w(f), f \in [f_0, f_N]....$$

α_n^2 – Signal power density within the n^{th} band

$s_n(f), s_w(f)$ – PSD of signal and noise.

$f \in [f_0, f_N]$ – Wideband frequency range.

The wavelet based detection is a one of the coherent sensing methods have knowledge about the presence of known signal, received signal. In these method is compared to the know signal parameter in this manner it has been detect the presence and absence of the primary user signal [12] [13] and received signal output is compared with the threshold value in order to detect the presence of the primary user. The strength of the received signal is more than the transmitted signal.

$$M = R[\sum_{n=1}^{N} \gamma(n)x^{*}(n)].....$$

Where,

$*-$ Represent conjugate operation.

R – Real part

There must be known patens if the received signals are obtained from primary user signal. Hence the correlation will be more than threshold value of the signal. But in the case of the noise, the pattern will be unknown of the received signal so the correlation will be less than the threshold value .There are few advantages of method that it has fast sensing and more reliable in nature but one of the disadvantage is for higher accuracy requires a longer length of known sequence which result for lower efficiency of the spectrum.

VI. COMPARATIVE ANALYSIS

Comparative analysis of each technique[5] based on the different parameter of their analysis which required to deal with the real time application .These paper is related to the detailed description of the different types of the spectrum sensing techniques which provides researches to focus in research field.

TABLE: 1 Comparative Analysis of Various Spectrum Sensing Methods

Parameters	Matched Filter	Energy Detection	Cyclostationatiory	Wavelet Transform
Spectrum Sensing Time	Very less	Very very less	Large	Very large
Prior Information	Yes	No	Yes	Yes
Power Consumption	Medium	Very very low	High	Very High
Nature	Coherent	Non Coherent	Coherent	Coherent
Narrow /Wide band sensing	NB	NB/WB	NB	WB
Reliability	Very good	Very very poor	Good	Medium
Accuracy	Very good	Very very poor	Good	Medium
Processing Gain	High	Low		
Computational Complexity	Very low	Very very low	High	Very high
Cost	Very low	Very very low	High	Very high

VII. CONCLUSION

As per the demand of the user the frequency spectrum is increases day by day , it become a more vital role for accessing the spectrum .These increasing demand of bandwidth for effective communication requires efficient spectrum of communication .A cognitive radio is a novel approach for efficient utilization of spectrum . Cognitive radio is a smart method of sharing the spectrum in an opportunistically. In various function of CR, spectrum sensing is the most important to guarantees vacant frequency .In this paper we research various spectrum sensing methods and proposed efficient spectrum sensing and made comparative analysis of spectrum. Cognitive radio was introduced to utilize the holes present in the spectrum. The most essential approach of a cognitive radio system is spectrum sensing and various sensing techniques which are used to sense the spectrum

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