A STUDY ON SPECTRUM SENSING METHODS OF COGNITIVE RADIO

M.Lakshmi[#1], R.Saravanan[*2], R.Muthaiah[#3]
School of Computing, SASTRA University, Thanjavur-613402, India
[#1]mlakshmi.s15@gmail.com
[*2]saravanan_r@ict.sastra.edu
[#3]sjamuthaiah@core.sastra.edu

***Abstract*: Cognitive radio (CR) is a promising technology which avoids congestion in wireless communication by exploiting unused radio spectrum. The Spectrum sensing (SS) plays a fundamental requirement of CR which finds an unused free spectrum and detects the licensed user transmissions. This paper constitutes the study about the classification of spectrum sensing in energy detection, cyclostationary, matched filter, MRSS.**

Keywords: Cognitive Radio (CR), Primary User (PUs), Wide Sense Stationary (WSS), Auto Correlation Function (ACF), Power Spectral Density (PSD)

I. INTRODUCTION

Cognitive radio is an attractive result to the spectral congestion tricky by presenting the resourceful procedure of frequency band channels that can not be greatly captured by users who holds the license. They cannot be exploited by others except license holders at the moment. Orthogonal Frequency Division Multiplexing is the most widely used technique in recent wireless communication systems which has the latent of satisfying the necessities of cognitive radios intrinsically otherwise minority changes will be held. With it interoperability among the different protocols becomes easier which is one of the significant necessities in Cognitive radio.

Cognitive Radio exploits the sparsity of the spectrum sensing.The spectrum sensing techniques provides more spectrum admission chances to cognitive radio handlers not having intrusive with the operations of the licensed network.SS is the duty of gaining consciousness regarding the spectrum utilization and presence of primary holders in a communication bandwidth. Few of the widely used common. Spectrum sensing methods are

1) Energy detector
2) Cyclostationary
3) Matched filter

In this paper MRSS method is compared with the above 3 methods.

II. ENERGY DETECTION

The Energy detection does not need extra information about the Primary users and therefore it is more popular**.** The Energy detection method is a non-coherent detection that uses the received signal energy to resolve the existence of a primary signals.

In general CR user does not estimated to be provided with any preceding information about the primary signals that may be present with in an assured frequency band. When the secondary recipient cannot draw together any required data, then the energy detection can be used because of its capability to work regardless of the structure of the signal need to sense.

Fig 1. Energy detector block diagram

Two premises

1) HO (PU is absent)
   Under HO: x (n) = w (n), (noise only)
2) HI (PU is in operation)

Under HI: x (n) = h s (n) + w (n), (signal with noise),

n = 0, I, 2, N- 1.

Here, n = 0, 1, 2, ..., N-1, N represents the index of sample, x(n) specifies received signal ,w[n] specifies the noise and s[n] is the primary signal required to detect.

Energy detection can be done by comparing the received signal's energy with certain frequency band to properly set well known decision threshold. In case of, the signal energy lies superior to the threshold, and then the band is declared as busy. Otherwise the band is said to be idle (free) and could be accessed by CR users .Energy detector is otherwise known as periodogram or radiometry, and the most usual scheme of SS due to its least computations and application diffficulties.Few difficulties occurred in this scheme includes a choice of the threshold for detecting PUs, incapability to discriminate intervention from PUs and noise, It has poor presentation under low SNR. Furthermore, energy detectors do not work effectively for recognizing the spread spectrum signals.

III. CYCLOSTATIONARY

Cyclostationary or Feature detection based spectrum sensing utilizes the exclusive prototype of the signal to detect its existence. It is trickier to the CR handler's transmissions by abusing the cyclostationary characteristics of the received signals. Cyclostationary features are produced by the Regularity in a signal or in its functions such as Mean and ACF or they can be calculatedly apply and sensitive to the impairments between the cyclic frequency, carrier frequency and sampling frequency.Cyclostationary is a scheme for detecting primary induced to aid spectrum sensing. In place of PSD, cyclic correlation function is used for detecting signals exist in a known spectrum. The procedures of cyclostationary based detection can be used to discriminate the noise from PUs' signals. This is an outcome of the fact that noise is WSS without any correlation whereas the modulated signals are cyclostationary to the spectral correlation because of the regularities of reputed signal.

IV. MATCHED FILTER

It performs coherent detection. It acquires optimal solution to the signal detection but it requires preceding knowledge on the received signal. Matched-filtering is acknowledged as the most favorable techniques for the sensing of PUs while the transmitted signal is known. The foremost benefit of matched filter is the tiny time to attain a particular set probability of false alarm or probability of miss detection as compared to remaining methods. In reality, the required number of samples can be developed as O (1/SNR) for a target to get probability of false alarm at low Signal to Noise Ratios of matched-filter.

Here the transmitted signal is passed through the channel where the additive white Gaussian noise is getting included to the signal and outputted the mixed signal. This mixed signal is given as an input of the filter.Then the matched filter input is convolved with the impulse response of the matched filter and the matched filter output is then compared with the decision threshold for primary user detection.

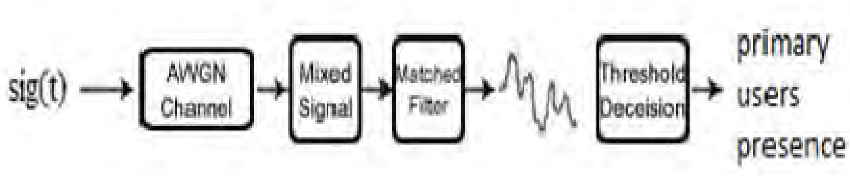

Fig 2. Matched filter block diagram

However, the Matched filter needs CR to demodulates the received signals. Later, the filter needs great information of the PUs signaling characteristics namely Frequency of operation, bandwidth, modulation methods, pulse shaping, and frame format. An execution complication of sensing unit is unfeasibly very huge. A drawback of the matched filtering is huge power utilization as varieties of receiver schemes require to perform recognition.

V. MULTI-RESOLUTION SPECTRUM SENSING

RF front end and Analog wideband spectrum sensing (reconfigurable) accepts the wavelet based transform is used to propose the multi-resolution sensing feature. The Flexible energy detection based spectrum sensing utilizes the Wavelet based transform and can be set to a input and the resultant coefficient levels are stands for the illustration of the input signal's spectral filling with a known sensing promise. Fourier transform is used by the MRSS to sense the spectral apparatus of incoming signals. The Fourier Transform can be achieved in analog fashion. The MRSS may utilize the wavelet based transforms as the basic purpose of the Fourier Transform. Center frequency Bandwidth, Resolution and can be synchronized using wavelet based functions.

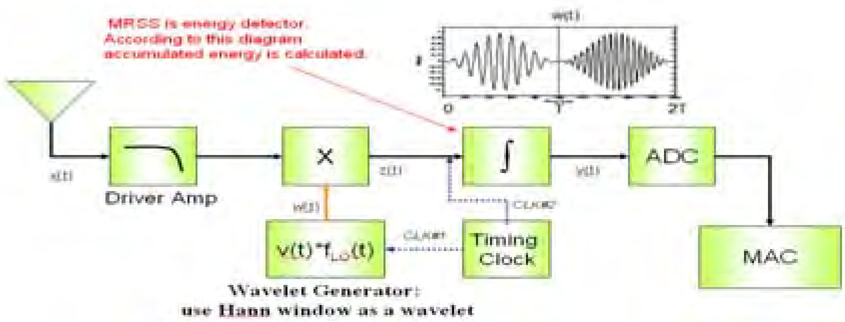

Fig 3. MRSS block diagram

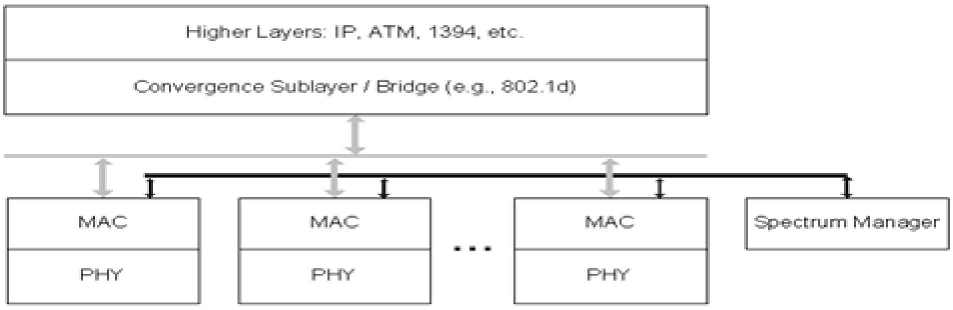

Fig 4. MRSS Layered Operation

$$w[k+1] = 0.5\left(1-\cos\left(2\pi\frac{k}{n-1}\right)\right), \qquad k = 0, \ldots, n-1$$

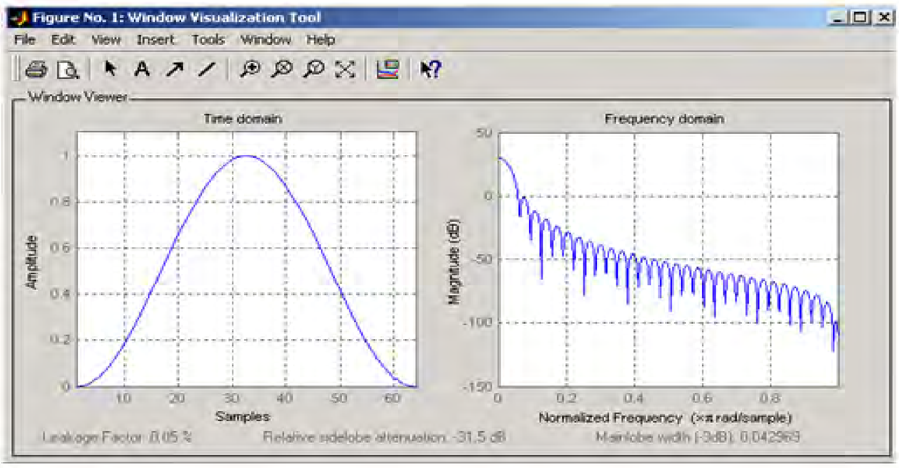

Fig 5. HANN window

A. BUILDING BLOCKS OF MULTI RESOLUTION SPREAD SPECTRUM

MRSS includes the following atomic units

1) The Analog waveform generator consists of Wavelet based pulses. It can be produced then modulated with I and Q. A Hann window with 5 MHz bandwidth is selected as the wavelet.

2) Oscillator (Local oscillator LO) Using this LO, the spectrum series with a precise period, signal power and frequency values are sensed over a spectrum range.

3) Multiplier (analog)

4) ADC (Low speed) it digitizes, a deliberated analog correlation values. Digitized values are noted operations of MRSS

5) Integrator (Analog integrator) it is used to analyze the correlation with the wavelets to a known spectral width. The resultant correlation with I and Q elements of input to Analog to Digital Converter.

In case of superior correlation levels with decision threshold level, the sensing system decides its importance of interferer reception. As the investigations are achieved in analog fashion so that the low power consumption and high speed operation can be established. By giving the thin wavelet based pulses and huge step size of tuning LO, the MRSS can examine the very wide spectrum span in the speed and light approach. In divergence, very accurate spectrum probing is understand with the extensive wavelet pulse and the slightly changing the LO frequency. By feature of the scalability of the wavelet based transform, multi-resolution can be obtained without any extra digital hardware burdens. Dislike heterodyne based spectrum analysis patterns; it does not require any physical filters for figure negation because of the effect of filtering the window signals.

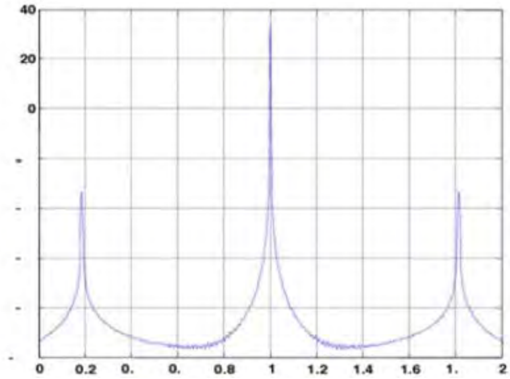

Fig6. The spectrum of the wireless Microphone signal (Power Spectrum magnitude Vs. Frequency)

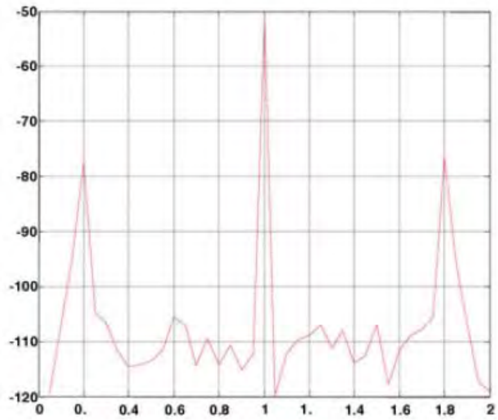

Fig 7. The spectrum detected with the MRSS technique (PSD Vs Frequency)

VI. CONCLUSION

As the results of comparison of all of the Energy detection, Matched filter, Cyclostatioanary based detectors with MRSS shows that MRSS can does the stretchy detecting and can be established on analog domain with Full analog signal process, Drastically reduce power consumption, Faster recognition, Flexibility in sensing resolution and speed Filter is not required on the sensing path Wideband operation Relaxing RF components constraint (Noise, Linearity).

REFERENCES

[1] G. R. Faulhaber, "Deploying cognitive radio: economic, legal and policy issues," International Journal of Communication" vol. 2, pp. 1114-1124, Aug 2008.

[2] S. Haykin, "Cognitive radio: Brain-empowered wireless communications," IEEE Journal on Selected Areas in Communications" vol. 23, no. 2, pp. 201-219, Feb 2005.

[3] K. Larson (Chair), L. Cacciatore, T. Eng, J. Jackson, B. Luther, and T. Magnire, "Fcc: Spectrum policy task force: Report of the interference protection working group," Federal Communications Commission, Tech. Rep., 2002.

[4] S.Srinu, Samrat L. Sabat," FPGA implementation of Spectrum Sensing based on Energy detection for Cognitive Radio ".

[5] T. Yucek and H. Arslan, "A survey of Spectrum Sensing Algorithms for cr Applications first quarter 2009," University of South Florida, USA, Rep., 2009.