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Cognitive Radio based Spectrum Sensing using different Wavelet Methods

Yamini Likhar[1], Mr. Ankit Chouhan[2]

[1]Student, Department of Electronic & Communication,
Patel College of Science & Technology Madhya Pradesh, India
[2]Asst. Professor Department of Electronic & Communication
Patel College of Science & Technology Madhya Pradesh, India

Abstract –*Spectrum sensing is used to identify as a key factor to ensure the functionality of cognitive radio which would not interfere with the primary use signals. The cognitive radio is a type of the radio that has the ability to change the transmission and reception parameter based on the operating environment. Cognitive radio is a type of techniques which support the dynamic spectrum sensing technique which provides the platform to the secondary user to access the underutilized spectrum sensing on the basis of estimated SNR for the available channels. The proposed method is used to analysis performance of the SNR and the probability of detection using different wavelet family and also the comparative analysis of them.*

Key Words: ***Cognitive Radio(CR),Spectrum Sensing, Energy detection(ED), Wavelet Transform(WT), Discrete Wavelet Transform(DWT), Maxcian, Morlet, Meyer, Biorthogonal.***

1. INTRODUCTION

The emerging technology based on the new wireless application, which is highly definition application has present in the communication system. At present the new enhancing technology based in wireless communication for the utilization of the available free spectrum. Cognitive radio is mainly designed in order to provide highly reliable communication for all the user of the network , and to facilitate the effective utilization of the radio spectrum.
Spectrum sensing in cognitive radio:- A main tasks in cognitive radio [3][4] is that the secondary user need to predict the presence of the primary user in a licensed spectrum and quite the particular frequency band. If the primary user is available in the spectrum in order to avoid the interference to the primary user [11][12]. This types of the techniques is to called spectrum sensing. Spectrum sensing based sensing [10][13] is ability to sense and aware of the characteristics of the radio spectrum. These application and user requirement are measured with the other operating restrictions.

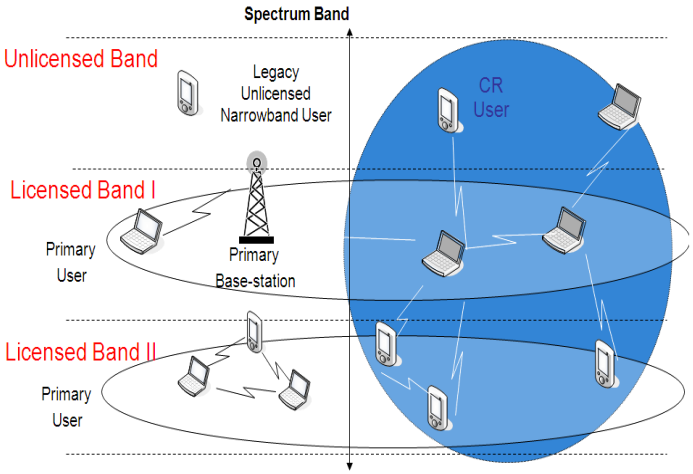


Figure: - 1.1 Spectrum sensing in cognitive radio

2. REVIEW PAPER

2.1 First Paper:-

A paper A paper "Analysis and implementation of a wavelet based spectrum sensing method for low SNR scenarios" D. Cariplione G. Cerro, L Ferrigno Department of Electrical and Information Engineering University of Cassino and southern Lazio 2016.
In this paper is based on the primary user and access to the spectral resources opportunistically. Among the available method a surely promising approach is the wavelet based one. It allows to sub divide the wide band spectrum under analysis in a proper no of sub bands, based on power spectral density irregularities remarked by the extreme of the continuous wavelet transform first derivative. Generally, such kind of method works well as long as good signal to noise ratio can be experienced over the span of interest. In these contexts, starting from an approach present in literature, the present work proposes, customizes and implements a wavelet based spectrum sensing method, thought to operate also in challenging SNR scenarios.

2.2 Second Paper:-

A paper [3] Saloni, Pankaj Batra: "Spectrum Sensing in Cognitive Radio by Statistical Matched Wavelet Method and

Matched Filter" International Journal of Electronics & Communication Technology Vol. 7, Issue 1, ISSN : 2230-9543 IJECT 2016, pp 33-39 39 Jan - March 2016.
In these papers is based on the statistical matched wavelet based spectrum sensing in cognitive radio using MATLAB. In these we are generating non periodic signal comprises of more than one frequency with AWGN. Each of the frequency of the primary user is of statistical matched with wavelet transform with original non periodic signal with noise. The main aim of this paper is to reduce noise and detect the primary user and also find the unoccupied part of the channel which is useful to primary user. So that the spectrum is fully utilize for type of communication purpose through these paper. As a result of these paper is very good result in terms of the wide band spectrum. In this paper one of the problems is that is gives best result only in the wide band spectrum not for the narrow band and also for, the larger number of the user to sense the unused part of spectrum. Here sensing needs them to define the threshold level in according the value of the SNR so we can say that the part of the spectrum is not used in this method.

2.3 Third paper:-

A paper Priya Goyal, Avtar Singh Buttar, Mohit Goyal "An Efficient Spectrum Hole Utilization for Transmission in Cognitive Radio Networks " International Conference on Signal Processing and Integrated Networks (SPIN) 2016 .
In this paper is based on the Cognitive Radio (CR) seems to be a solution of the problem of the spectrum underutilization and the spectrum scarcity .Among the various systems of the CR system, spectrum sensing is important function which detect the vacant space from the surrounding spectrum, that space can be utilized by the secondary user to high accuracy efficiency In this paper, an Efficient Approach for Spectrum Utilization is proposed, using Wavelet Packet Transform (WPT) Technique based on the entropy estimation. In this the cognitive radio , task provided to wavelet packet transform for carrier the imp information ie frequency location , sub bands , spectrum holes estimation .These proposed method is for the utilization of the interested spectrum band .As the decomposition level increases the more amount of the spectrum holes is found in the network . but here one of the problem with the proposed method is that as the no of the user increase then we need more the number of the CR to sense the spectrum on the same bandwidth which is not possible. Here the range of the SNR is fixed ie 10 db to -15 db through which we cannot extend the SNR out of the range . So this one of the limitation of the paper .

2.4 Fourth paper :-

A paper Osama Elnahas1, Maha Elsabrouty " Wideband Spectrum Sensing Technique Based on Multitask Compressive Sensing". IEEE Symposium on Computers and Communication (ISCC).
In this paper is based on the spectrum sensing based cognitive radio using WMCS algorithm for constructing the spectrum edges directly from the compressive measurement. These algorithm does not required any prior information of the about the signal and its properties. The WMCS algorithm forms new compressive sensing (CS) tasks by using the wavelet transform of the power spectral density at different scales. The algorithm then forms the spectrum sub bands using the estimated edges and classifies the sub bands as either occupied or sparse. In this algorithm is based on detecting the band boundaries in wide band signal from compressive measurement is developed occupancy at different bands. In this they are developed the multitasking algorithm for construction of the spectrum. This proposed method is improves the bands detection performance by using the MCS framework and synthesis using compressive sensing techniques .Here this method is based on the wavelet transform not on the energy detection therefore it has high computational and high complexity in nature . But one of the problem of this method one of the problem with this method.

2.5Fifth Paper:-

In the paper of Saloni Pandya , Prof. Rashmi Pant "International Journal Of Engineering Sciences & Research Technology performance Of Wavelet Packet Based Spectrum Sensing In cognitive Radio For Different Wavelet Families" .
In this paper is based on the spectrum sensing has been identified as a key functionality of the cognitive radio would not interfere with the primary user, which by reliable detecting the presence of the primary user signal. The researchers are focuses on the cooperative spectrum sensing technique to improve reliability of the spectrum but for cooperative spectrum sensing scheme are very difficult to tolerate with each individual node of the wireless network for the short time. This paper proposes energy detection based spectrums sensing for the different SNR. The proposed method which is also analysis performance of the SNR and the Decision Accuracy using different wavelet family and comparative analysis of the Haar, Symlets ,Coiflets and Dabuchesis wavelet in terms of different value of the SNR , Probability of Detection . In this paper, we have proposed a wavelet transform (WT) based on energy detection method in Cognitive radio (CR). In comparison through different value of signal to noise ratio (SNR) in terms of the Availability of Free spectrum and signal to noise ratio (SNR). But here the value of the SNR and the probability of the detection is fixed for the specified range .i.e. -40db to 0 db .Here if we to predict the value of Pd and the SNR beyond the range which is not possible.

3. WAVELET TRANSFORM AND WAVELET FAMILY

3.1 Discrete wavelet transform: -

The discrete wavelet transform [1][2] are applied to discrete set of pair to produce the different outputs. The discrete wavelet transforms one of the transformations of sampled signal into different wavelet coefficient. It is used to analysis the signal at the different level of the frequency band with its resolution by the approximation and detail information in the signal DWT .Theses function are composed of the high pass and low pass filter and these filter is used for the signal processing .The resolution of the signal , which is used for signal processing . The resolution of the signal which is used to obtained time and frequency analysis of the signal .These function are basically occur in the two parts low pass and high pass filter of the time domain signal. DWT is used for converting a time domain signal into frequency domain signal. This prototype is called the mother wavelet [5].

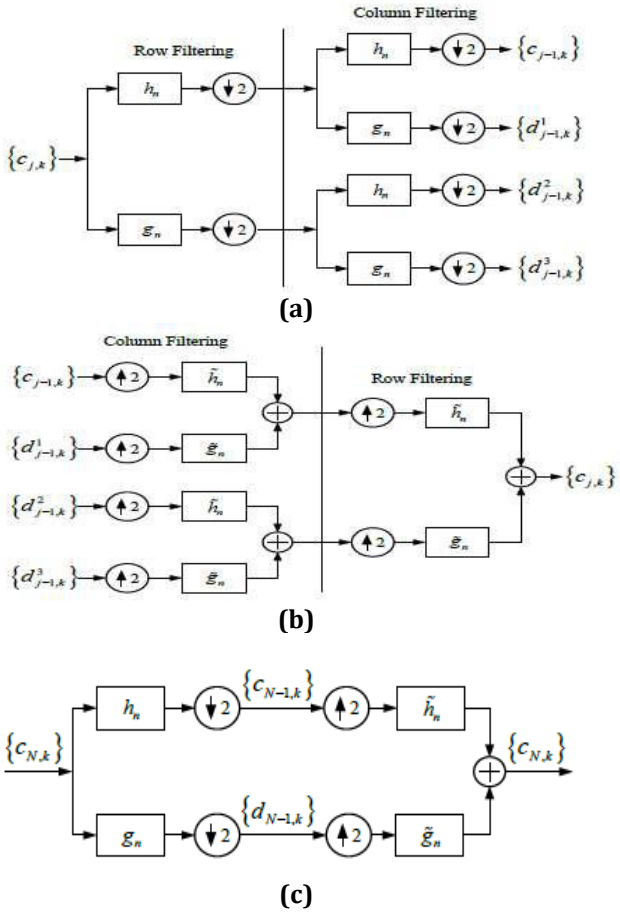
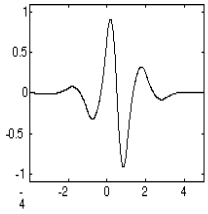


Figure1.2:- Reconstruction and decomposition process in wavelet transform

After the row and column filtering 4 different hands are obtained respectively. By continue the process we obtained the method [6]. On the contrary each reconstruction scheme I reverse process decomposition process.

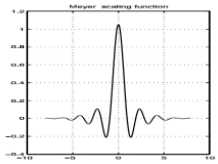
3.1.1 Biorthogonal Wavelet transform

The Biorthogonal wavelets feature a pair of scaling functions and associated scaling filters one for analysis and one for synthesis. There is also a pair of wavelets and associated wavelet filters, one for analysis and one for synthesis. The analysis and synthesis wavelets can have different numbers of vanishing moments and regularity properties. These wavelet[7] with the greater number of vanishing moments for analysis resulting [8] in a sparse representation, while use the smoother wavelet for reconstruction[9].



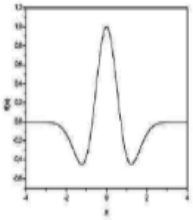
3.1.2 Meyer Wavelet transform:-

The Meyer wavelet and scaling function are defined in the frequency domain.



3.1.3 Mexcian Wavelet

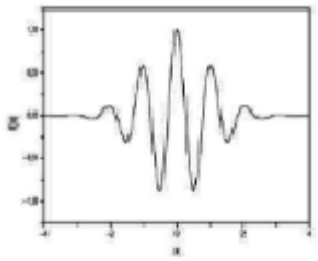
It is the second derivative of the Gaussian probability density function .Here it can be define as below mexh(x) = c * exp(-x^2/2) * (1-x^2)



3.1.4 Morlet Wavelet transform

These type of the wavelet is support on the time and frequency and rate of decay. In matlab it is represented by morl function as given below .

Definition: morl(x) = exp(-x^2/2) * cos(5x)



4. COMPARISON TABLE OF DIFFERENET WAVELET FAMILY

The comparative analysis of the different wavelet family is given below [14].

S. No.	Parameters	Biorthogonal	Meyer	Mexcian	Morlet
1	Orthogonal	No	Yes	No	No
2	Biorthogonal	Yes	Yes	No	No
3	Compact Support	yes	No	No	No
4	DWT	Possible	Possible but without FWT	No	No
5	CWT.	Possible	Possible	Possible	Possible
6	Support Width	2Nr+1 , 2 Nd+1	Infinity	Infinity	Infinity
7	Effective Support	-	[-8,8]	[-5 ,5]	[-4,4]
8	Regularity	Nr-1 and Nr-2 at the knots	Indefinitely derivable	--	--
9	Symmetry	Yes	Yes	Yes	Yes

TRANSMITTER

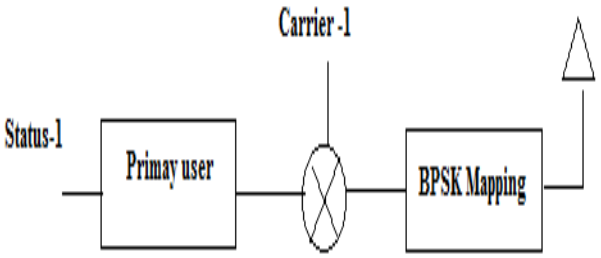


Figure 1.3 Block diagram of Transmitter

RECEIVER

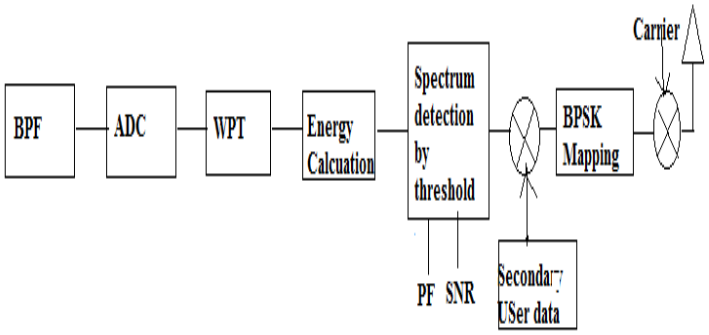


Figure 1.4 Block diagram of Receiver

5. RESULT AND SIMULATION

In this section we discuss the simulation of the discrete wavelet transform in which we chooses BPSK modulation as PU signal in the presence of the AWGN channel and SNR is changes from -40 db to 40 db. Here the sampling frequency is 20 MHz signal.

Table 1.2 Performance analysis of the SNR vs. Probability of Detection
Here in the above figure the signal from -40 to 27 db is zero i.e. it is not mentioned in the table.

S.No	SNR	Probability of Detection			
		Biorthogonal	Meyer	Mexcian	Morlet
1.	28	0	0	0	0
2.	29	0.4	0.3	0.2	0.1
3.	30	0.8	0.7	0.6	0.5
4.	31	1.2	1.1	0.9	0.5
5.	32	1.4	1.3	1.0	0.9
6.	33	1.6	1.4	1.2	1.1
7.	34	1.9	1.7	1.4	1.3
8.	35	2.2	1.9	1.5	1.4

9.	36	2.4	2.3	1.7	1.2
10.	37	3.6	3.2	2.4	1.9
11.	38	4.8	4.2	3.4	2.5
12.	39	6.0	5.5	4.2	3.2
13.	40	7.4	6.5	5.0	3.9

Table 1.3 Performance analysis of Mean Power Vs No. of users

S.No	No of user (t)	Mean power (mw)			
		Biorthogonal	Meyer	Mexican	Morlet
1.	0	6	0.9	0	0.7
2.	2	3.8	2.3	1.3	0.5
3.	4	2.2	1.5	1.3	0.4
4.	6	1.8	0.5	0.5	0.4
5.	8	1	0.8	0.4	0.4
6.	10	1.5	1	0.9	0.3
7.	12	1	1	0.9	0.3
8.	14	0.5	0.5	0.5	0.3
9.	16	0.3	0.3	0.2	0.2
10.	18	0.3	0.3	0.3	0.2
11.	20	0.5	0.4	0.3	0.2

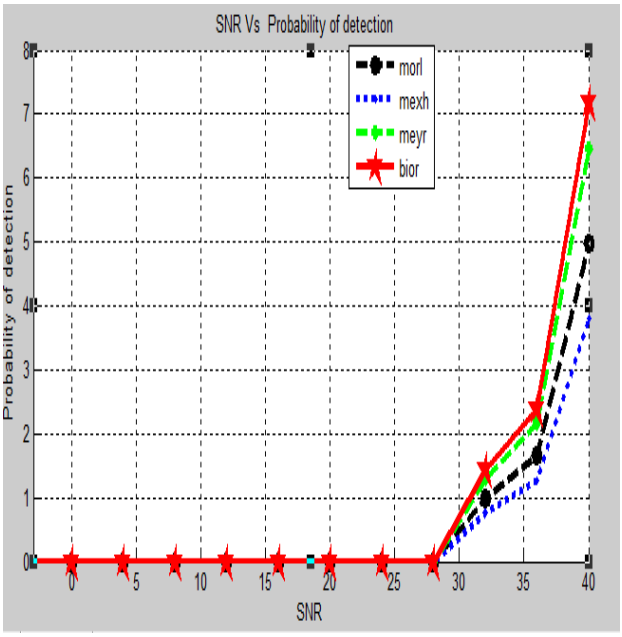


Figure1.5 Performance of SNR Vs Probability of Detection

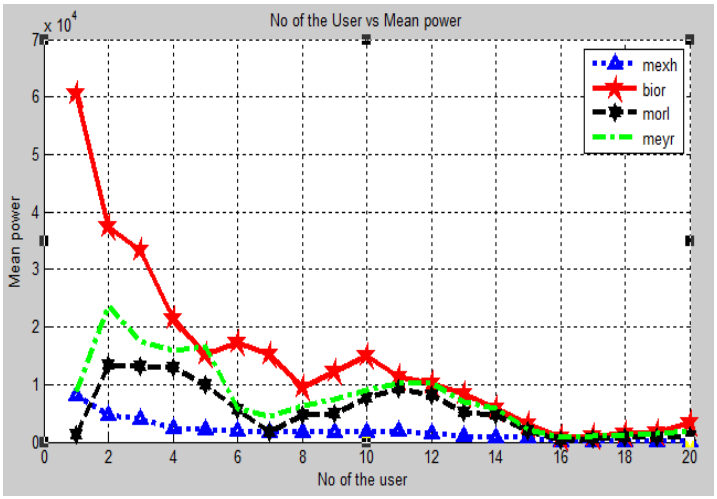


Figure1.6 Performance of Mean Power Vs No. of users

6. CONCLUSION

In this paper we have proposed a wavelet transform (WT) based on energy detection based method in cognitive radio (CR). In this paper we had made the comparison of the different vale of the signal to noise radio in terms of the Probability of the detection with respect to SNR. It is most efficient method to analysis the spectrum and which can improve the performance of the energy detection by measuring PD for the various value of the SNR and calculated the threshold value. This threshold can be accurately detecting the probability of the detection of the received signal using different type of the wavelet family. We also detected the Mean power of the signal with respect to its no of the user occupied the area.

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