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## PERFORMANCE OF WAVELET PACKET BASED SPECTRUM SENSING IN COGNITIVE RADIO FOR DIFFERENT WAVELET FAMILIES

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## ABSTRACT
Spectrum sensing has been identified as a key enabling functionality to ensure that cognitive radios would not interfere with primary users, by reliably detecting primary user signals. The cognitive Radio built on a software-defined radio, defined as an unpredictable growth of wireless communication scheme, which is automatic adjustment of the electromagnetic environment to adapt their operation and dynamically vary its radio operating parameters while bring no harmful interference to the primary use. 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.

**KEYWORDS**: Wavelet Transform (WT), Cognitive radio (CR), Energy detection (ED), Discrete Wavelet Transform (DWT), etc.

## INTRODUCTION
The cognitive radio is a metamorphosis technology in wireless communication scheme which is cognizant with the surroundings learn and opportunistically identify the portion of the spectrum without causing the harmfulness hindrance to the primary user such as to  make secure for efficient utilization of the radio spectrum highly reliable and maximizing the quality of the services. As the number of the user in the wireless network is increase, the huge demand of the radio spectrum increase in the wireless communication .The day to day updating technologies the new wireless devices and application will trends to increase the demand of the spectrum. The method of the detecting the availability of the primary user in a radio spectrum environment is called the spectrum sensing .There several method of the spectrum  sensing technique such as matched filter detection, energy detection , cyclostationary feature detection. Energy detection is the more robust technique with the low computationally complexity. In the energy detector is used to find the frequency spectrum   is vacant or not. In these paper are analysis   Performance of the wavelet transform based energy detector spectrum sensing and its comparison for different types of wavelet family.

## COGNITIVE RADIO ARCHITECTURE
Existing wireless network architectures employ heterogeneity in terms of both spectrum policies and communication technologies. Moreover, some portion of the radio spectrum is licensed for different technologies and some bands remain unlicensed (called Industrial Scientific Medical (ISM) band). The clear description of cognitive radio network architecture is essential for the development of communication protocols.
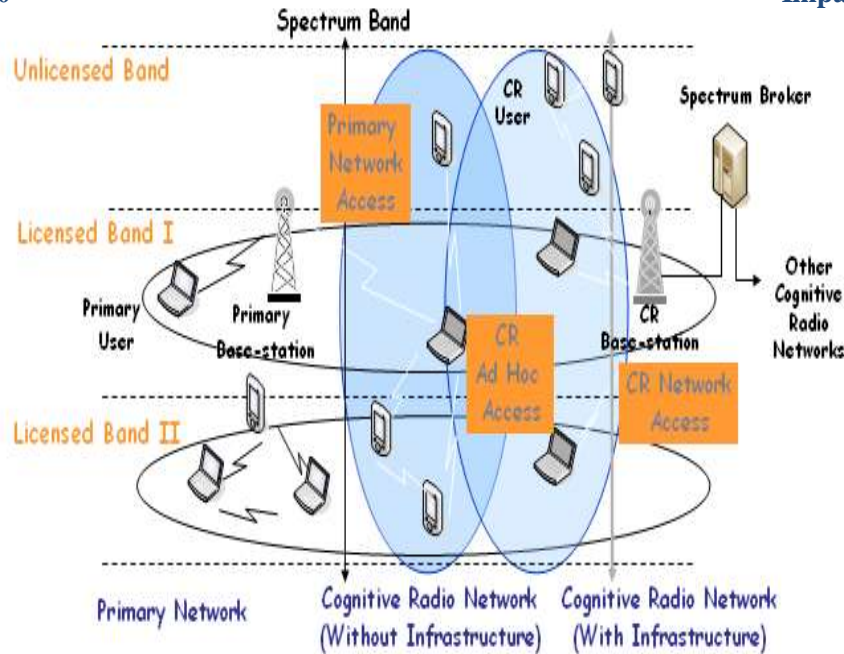
*Fig: 1 Cognitive Radio Network Architecture [3]*

The components of the cognitive radio network architecture, as shown in Figure 1, can be classified in two groups such as the primary network and the cognitive radio network.

## Wavelet Transform And Wavelet Family

### Biorthogonal Wavelet Transform

The biorthogonal wavelet transform is composed of the decomposition process and the reconstruction scheme with two different wavelets $\Psi$ and $\widetilde{\Psi}$. $\Psi$ is used in the decomposition process, and $\widetilde{\Psi}$ Is used in the reconstruction process. $\Psi$ and $\widetilde{\Psi}$ Are dual and orthogonal to each other, and this relationship is called biorthogonal. Meanwhile, there are two scale functions $\emptyset$ and $\widetilde{\emptyset}$ In the above processes, these two scale functions are also dual and orthogonal. One is used in the decomposition process, and the other one is used in the reconstruction process. Therefore, there are four filters in biorthogonal wavelet transform. They are the decomposition, low-pass filter $\{h_n\}$, the decomposition high-pass filter $\{g_n\}$, the reconstruction low-pass filter $\{\widetilde{h}N\}$ and the reconstruction, high-pass filter $\{\widetilde{g}n\}$ . Unlike the orthogonal wavelet transform, the reconstruction filters and the decomposition filters are different.

With filter coefficients $\{h_n\}$, $\{g_n\}$, $\{\widetilde{h}n\}$, and $\{\widetilde{g}n\}$, fast wavelet transform—Mallat algorithm [6] can be performed. The decomposition and reconstruction processes in $\{C_{N, k}\}$ using the Mallat algorithm are shown in Figure 1. What we can conclude from shown in Figure 3, the essence of Mallat algorithm is filtering the $\{C_{N,k}\}$ signal by decomposition filters $\{h_n\}$ and $\{g_n\}$ . Then the results are sub-sampled by factor 2. The results of decomposition have two parts. One part is the signal $\{C_{N-1, k}\}$ generated by the low - pass filter $\{h_n\}$, which can be seen as the approximation of the original signal. And the other part is the signal generated by high-pass filter, which can be seen as the detail of the original signal. The reconstruction process takes the reverse process to reconstruct the original signal by reconstruction filters $\{\widetilde{h}n\}$, and $\{\widetilde{g}n\}$.
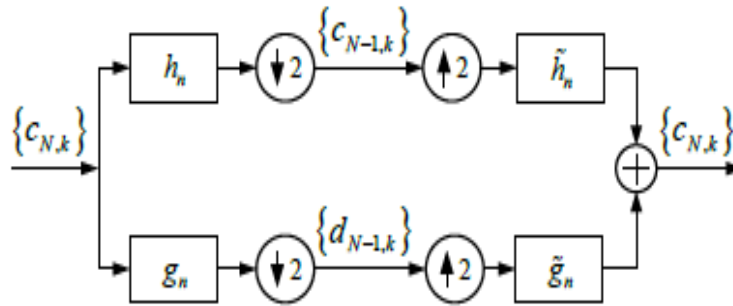
*Fig: 2 Decomposition and Reconstruction Processes of 1-D Mallat Algorithm*

Similar to the case of 1-D, and multi-resolution analysis of 2-D signals can be described as follows. Denote $\{C_{j,k}\}$ and $\{d^i_{j,k}(i=1,2,3)\}$ as the approximation and detail of 2-D signal f(x,y) at scale j respectively. If the original data can be considered as a 2-D discrete signal after the sampling scheme, the 2-D discrete wavelet transform (WDT) to signal $\{C_{j,k}\}$ can be indicated by Figure 2.
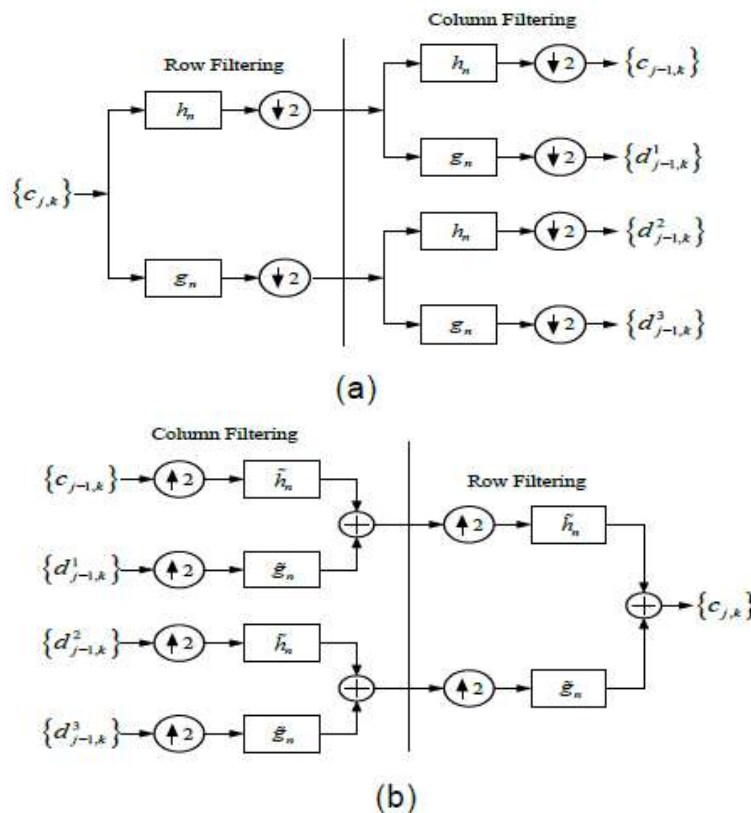


*Fig: 3 Separable Filter Banks: (a) Decomposition, (b) Reconstruction*

After the horizontal and vertical filtering processes, four different frequency bands $\{C_{j-1,k}\}$, $\{d^1_{j-1,k}\}$, $\{d^2_{j-1,k}\}$, and $\{d^3_{j-1,k}\}$ are obtained respectively. Continue to process with the method discussed above, we can get a pyramidal decomposition. On the contrary, each reconstruction scheme is the reverse process of the decomposition process.

*Haar Wavelet Transform*

There are two types of wavelet transforms the continuous wavelet transform and the discrete wavelet transform (DWT). The wavelet transform can be used to create smaller and accurate images, in which results a Multi-resolution Analysis. The discrete wavelet transform is an implementation of the wavelet transform. It uses a discrete set of the wavelet scales. In other words, in this transform decomposes the signal into a mutually orthogonal set of wavelets, which is the main difference from the continuous wavelet transforming (CWT) system, or its implementation for the discrete time series sometimes called discrete-time continuous wavelet transform (DT-CWT) system. Alfred Haar is a Hungarian mathematician invented the first DWT. The input in Haar wavelet is represented by a list of $2^n$ numbers. The Haar Wavelet transform firstly input is paired up, the difference is stored and passing the sum. Then the pairing of sum is done to provide the next scale finally resulting in $2^n$-1 differences and one final sum.

The Haar wavelet uses both low pass filter and high pass filters. They have used filters for image decomposition first in image columns and then in image rows independently. Four sub-bands produce the output of the first level Haar wavelet. The four sub-band named as LL1,HL1,LH1and HH1.The low frequency sub-band LL1 Can be further decomposed into four sub-bands LL2,HL2,LH2 and HH2.The other three sub-bands are the high frequency parts in the vertical, horizontal and diagonal directions.

The Haar wavelet transform has a number of advantages:

- It is a conceptually simple.
- It is memory efficient, since it can be calculated in place without a temporary array.
- It is exactly reversible without the edge effects that are a problem with other wavelet transforms.


Symlets wavelet: - They are the modified version of daubechies wavelet increased in symmetry. Its is also known as the least symmetry .It is define by positive interger N. The  scale function  and wavelet function has the compact support length 2N. N is the vanishing moments.
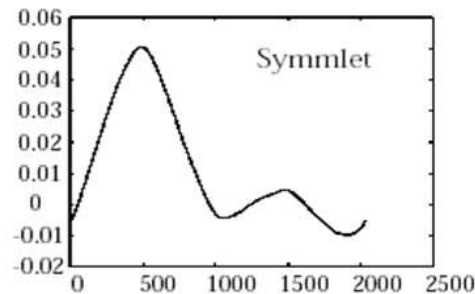


*Fig: 4 Symlets  wavelet transform*

*Coiflet wavelet*

It is used in discrete wavelet transform .To having scaling function with vanishing moment. The wavelet  is the nearly of symmetric  and their wavelet  function is N/3 and vanishing moment and scaling function is N/3-1 .Scaling function is high  pass filter and wavelet function is a low
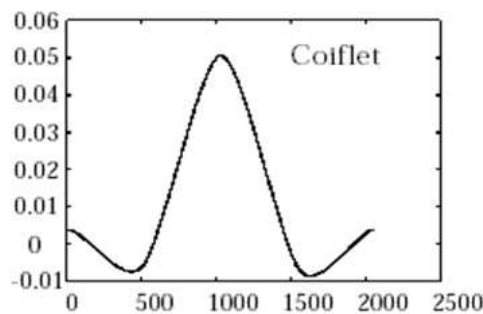


*Fig: 5 Coiflet  wavelet Transform*

*Dabaubhsis wavelet*

Dabaubhsis wavelet is used to generate progressively finer discrete samplings of mother wavelet function. so that each resolution will become twice to its pervious scale. It is a family of the orthogonal wavelet which characterized the signal with the maximal number no of the vanishing moments of a given support widen 2N and possible no of combination 2^N-1 possible solution the one is chosen for external phase .It is the one that solve broad range of the problem.
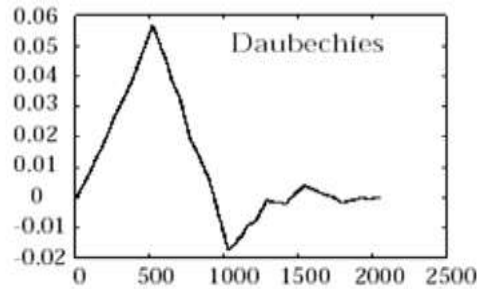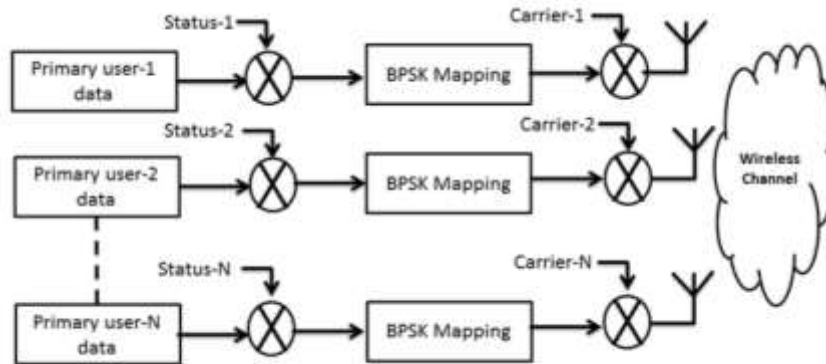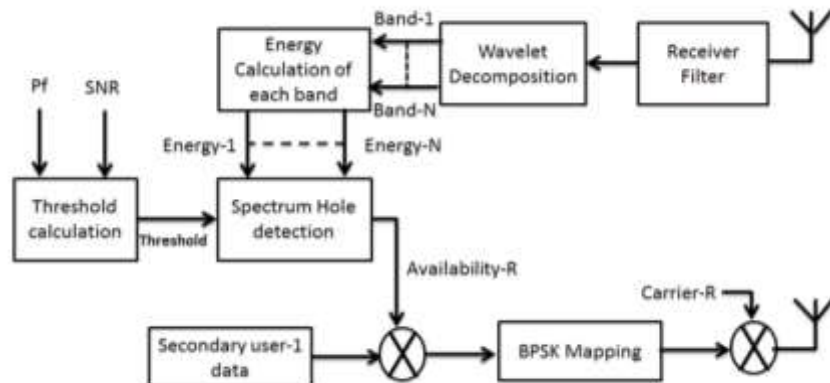


*Fig: 6 Dabaubhsis wavelet Transform*

# SYSTEM DESCRIPTION
## TRANSMITTER:



## RECEIVER:



# RESULTS AND DISCUSSION

In this section we give the simulation of discrete wavelet transform in which chooses BPSK modulation as PU signal in the presence of the AWGN channel and SNR is Changes from -40 dB to 0 dB. Here the sampling frequency is 20 MHz signal.
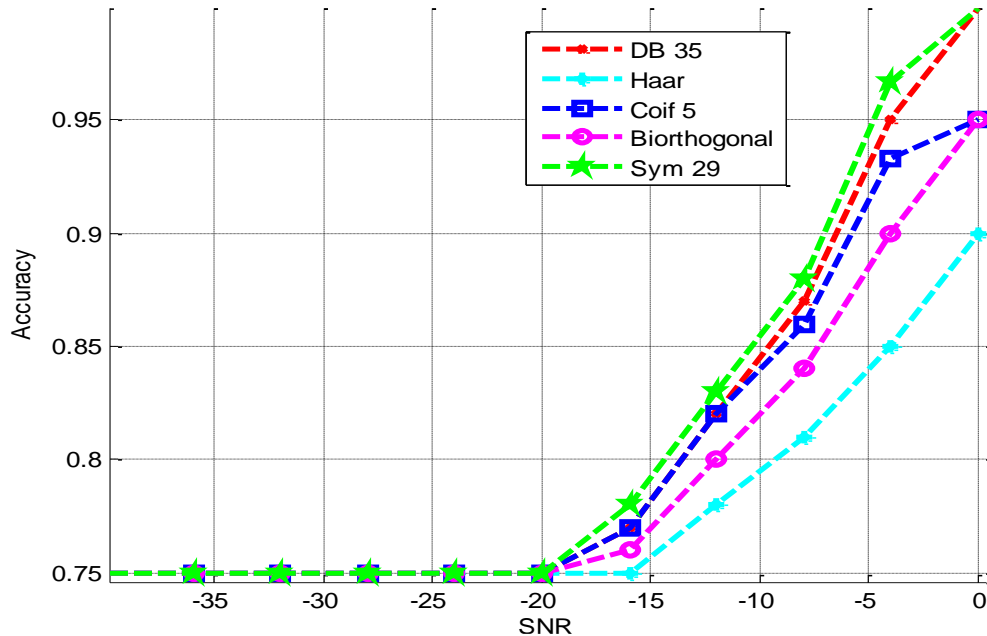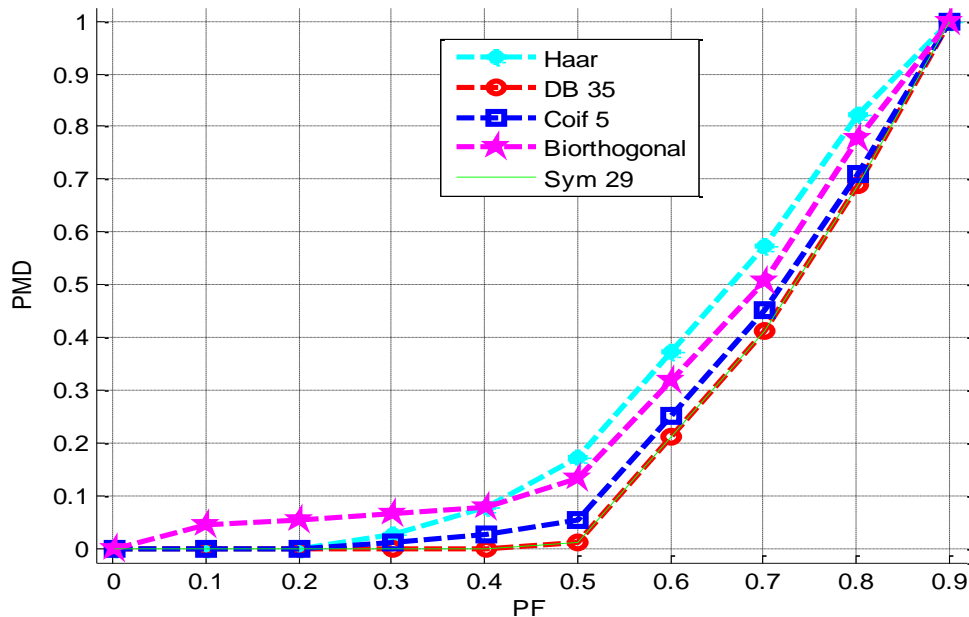


*Fig: 7  Performance of SNR Vs Accuracy*



*Fig: 8 Performance of PF Vs PMD*

*Table: 1 Performance parameter of SNR Vs Accuracy*

| SNR | Accuracy | | | | |
|---|---|---|---|---|---|
|  | Haar | DB | Coif | Bior | sym |
| -40 | .75 | 0 | .75 | .75 | .75 |
| -35 | .75 | 0 | .75 | .75 | .75 |
| -30 | .75 | 0 | .75 | .75 | .75 |
| -25 | .75 | 0 | .75 | .75 | .75 |
| -20 | .75 | 0 | .75 | .75 | .75 |
| -15 | .76 | .78 | .78 | .77 | .79 |
| -10 | .79 | .85 | .84 | .82 | .85 |
| -5 | .81 | .92 | .89 | .86 | .92 |
| 0 | .87 | 1 | .95 | .93 | .95 |

*Table: 2 Performance parameter of PF Vs PMD*

| PF | PMD | | | | |
|---|---|---|---|---|---|
|  | Haar | DB | Coif | Bior | sym |
| 0 | 0 | 0 | 0 | 0 | 0 |
| .1 | 0 | 0 | 0 | .05 | 0 |
| .2 | 0 | 0 | 0 | .05 | 0 |
| .3 | .05 | 0 | .02 | .07 | 0 |
| .4 | .1 | 0 | .03 | .08 | 0 |
| .5 | .2 | .05 | .05 | .15 | .02 |
| .6 | .4 | .2 | .25 | .32 | .2 |
| .7 | .6 | .4 | .45 | .50 | .4 |
| .8 | .8 | .7 | .7 | .80 | .7 |
| .9 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 |

**CONCLUSION**

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). It is an efficient perspective method to classify the spectrum which improves the performance of the energy detector by measuring the PMD for various SNR and calculated threshold value. Threshold which can accurately detect the Probability of the Detection of the received signal using different types of wavelet family.

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