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Cognitive Radio

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Abstract— **Cognitive Radio offers a solution by utilizing the spectrum holes that represent the potential opportunities for non-interfering use of spectrum which requires three main tasks- Spectrum Sensing, Spectrum Analysis and Spectrum Allocation. Spectrum sensing involves obtaining the spectrum usage characteristics across multiple dimensions such as time, space, frequency, and code and determining what type of signals are occupying the spectrum**

The development of a reliable and accurate spectrum sensing is very essential to propound quick and accurate detection of white spaces for better throughput of Secondary User network under the constraint of the specified Primary System protection. In this paper, a Cooperative Spectrum Sensing using Wavelet Denoising along with Soften Hard Decision technique has been proposed to improve the performance of spectrum sensing. Simulation result shows an improvement of nearly 15% in the Probability of Missed Detection for a target Probability of False Alarm of 0.1 and SNR of -10 dB. Also 50% improvement in error probability has been achieved with 1-D one level wavelet denoising.

Index Terms— **Microstrip Antenna, DST**

I. INTRODUCTION

According to survey of Federal Communications Commision (FCC) in 2002, it has been found that spectrum access is more significant problem than physical scarcity of spectrum [5].With many technological advances in the field of wireless communication and 3G, 3.5G, 3.75G and 4G technology already being employed Multimedia Broadcast and Multicast Services (MBMS) demand has tremendously increased and with the standardization of MBMS it has gained significant interest in the market. Multimedia content requires more bandwidth, storage capacity and few applications pose tight delay constraints, so the need to optimize the utilization of spectrum is felt all the more. Cognitive radio arises to be a tempting solution to spectral crowding problem by introducing the opportunistic usage of frequency bands that are not heavily occupied by licensed users since they cannot be utilized by users other than the license owners at the moment. Orthogonal Frequency Division Multiplexing (OFDM) is one of the most widely used technologies in current wireless communication systems which has the potential of fulfilling the requirements of cognitive radios inherently or with minor changes. With it interoperability among the different protocols becomes easier which is one of the important requirements in Cognitive radio

II. COGNITIVE RADIO

Cognitive Radio (CR) is a system/model for wireless communication. It is built on software defined radio which is an emerging technology providing a platform for flexible radio systems, multiservice, multi-standard, multiband, reconfigurable and reprogrammable by software for Personal Communication Services (PCS). It uses the methodology of sensing and learning from the environment and adapting to statistical variations in real time. The network or wireless node changes its transmission or reception parameters to communicate efficiently anywhere and anytime avoiding interference with licensed or unlicensed users for efficient utilization of the radio spectrum.

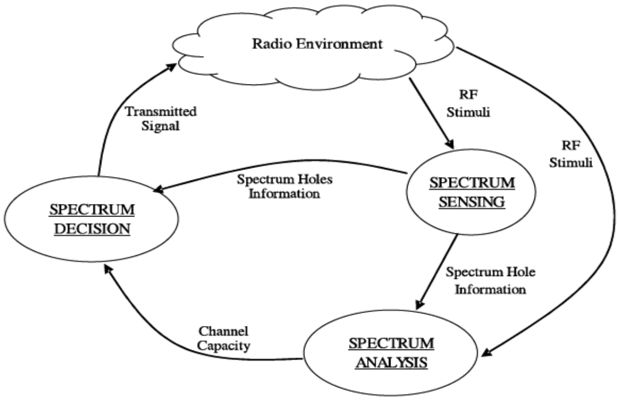

Figure 1 **Cognitive cycle**

III. ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING

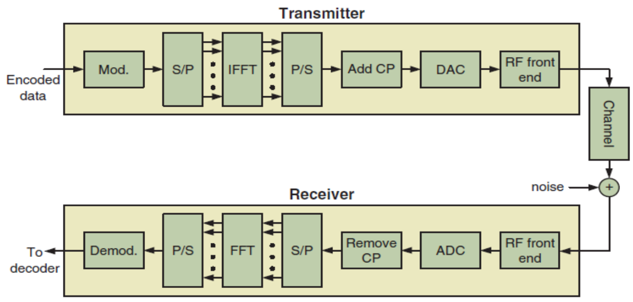

Figure 2 - Basic block diagram of OFDM transceiver

To avoid ISI, symbols duration is extended by adding a guard band to the beginning of each symbol in what is known as Cyclic Prefix (CP).If we define the delay spread (or multipath spread) of the channel as the delay between the first and last received paths over the channel, the CP should be longer than that delay. However, to avoid fast fading effect, OFDM symbol time is chosen to be shorter than the coherence time of the channel. In the frequency domain, mobility results in a frequency spread of the signal which depends on the operating frequency and the relative speed between the transmitter and receiver, also known as Doppler spread. Doppler spread of OFDM signals results in Inter-Carrier Interference (ICI) which can be reduced by increasing the subcarrier spacing.

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IV. SPECTRUM SENSING

Spectrum sensing is the ability to measure, sense and be aware of the parameters related to the radio channel characteristics, availability of spectrum and transmit power, interference and noise, radio's operating environment, user requirements and applications, available networks (infrastructures) and nodes, local policies and other operating restrictions. It is done across Frequency, Time, eographical Space, Code and Phase.

V. WAVELET PACKET TRANSFORM

For application of interest noise is primarily of high frequency and the signal of interest is primarily of low frequency. The wavelet transform decomposes the signal into approximation (low frequency) and details (high frequency) coefficients, the detail coefficients containing much noise. The simple method to denoise the signal is to simply reduce the size of the detail coefficients before using them to reconstruct the signal

VI. ENERGY DETECTION MODEL BASED ON WAVELET

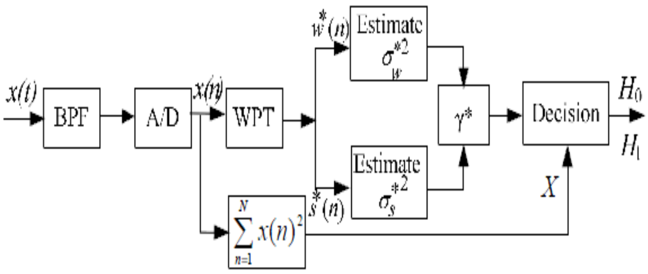

Figure 3 - Block diagram of Energy Detection Model based on WPT

The block diagram is similar to the simplest energy based detector but most importantly a Wavelet Packet Transform (WPT) block has been introduced which estimates the current noise and signal power, which is very important for settling threshold. The analog signal x(t) after being converted into digital signal x(n) is decomposed for a certain level related to the resolution required and then is reconstructed by wavelet packet decomposition coefficients. And hence the noise power and reconstructed signal power is estimated.

VII. ANALYSIS

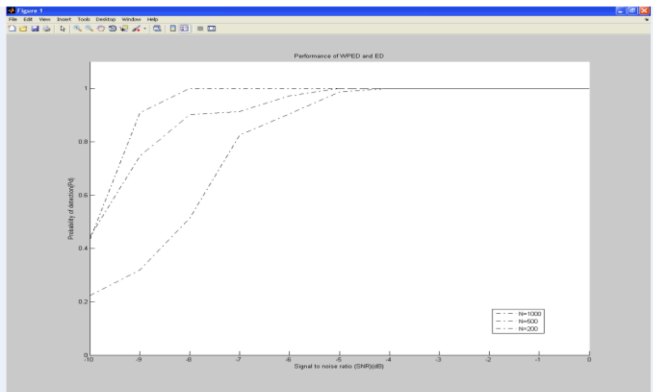

Figure 4 - Simulation of PD vs SNR using WPT under different sample numbers

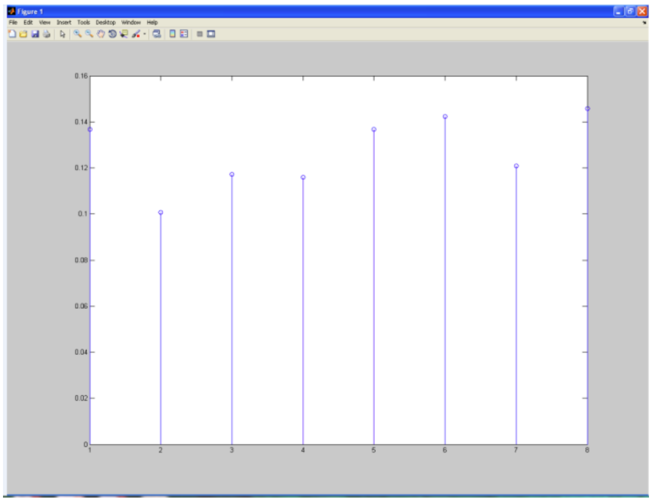

Figure 4 - Simulation of PD vs SNR using WPT under different wavelets

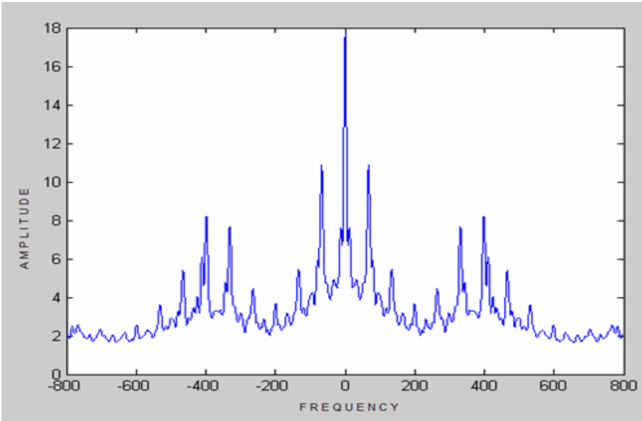

Figure 5 - Simulation of cyclostationary spectrum sensing with QPSK modulation

VIII. CONCLUSION

Energy Detection spectrum sensing using Wavelet Packet Transform (WPED) method outperforms the traditional energy detection method when the noise was unknown which is the real scenario. Hence it is quite a robust method for spectrum sensing in Cognitive Radio when the noise is unknown. As the sample number increases for performing spectrum sensing , the performance of the WPED method rises evidently. When the sample number is large enough the probability of detection is close to 1.

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