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Performance Exploration of Cyclostationary Skill In Spectrum Sensing

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ABSTRACT

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Although development of wireless communication can be attributed to the tremendous innovations of technology, nonetheless, spectrum scarcity downplays the efficiency of this technology due to increased demand on the spectrum.Cognitive radio can prove to be the best method for efficient use of the available spectrum for the unlicensed user. Studies have always highlighted orthogonal frequency division multiplexing (OFDM) to be the best choice for cognitive radio , this paper handles Multiband Orthogonal Frequency Division Multiplexing (MB-OFDM) as cognitive radio and cyclostationary detection as a spectrum sensing technique. A comparative study with that of energy detection method is furbished in this paper in addition to carrying out enhancing feature to identify the free spectrum holes.The efficiency of this technique is authorized by the results.

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INTRODUCTION

Proliferation of spectrum based devices in the recent years such as wireless LAN, TV broadcast,WiMAX,ZigBee,Bluetooth have resulted in high dependence on the radio spectrum. Such a flourished growth with users being ready to embrace the convenient wireless devices available today has resulted in spectrum scarcity problem being increased drastically(Mitola,2000; Haykin,2005). Considering the heavy demand in the available radio, it is clear that the spectrum would not be available for future use Cognitive radio is an emerging technology whose main objective is to identify the best available spectrum from the temporarily unused spectrum, referred to as spectrum holes,without interfering with the primary users(Ali*et al*, 2011).

Such a sharing of spectrum is termed as secondary usage of the spectrum. Conceptually, the primary access rights are possessed by the primary users while the secondary users could use these spectral resources by guaranteeing preservation of the interests of the primary users by providing the least interference possible.Thus cognitive radio acts as an extensive tool in accessing the spectrum and interoperability whose main characteristicsare re-configurability, self management and cognition.

Some of its main functions are spectrum sensing and analysis(Jian Chen *et al*, 2008). Spectrum sensing in simple words, does the work of detection of the spectrum holes in a geographical area. It is a first step of implementing the cognitive radio system. It is an important task of finding the white spaces in the spectrum band. Spectrum sensing can be classified into several categories: direct method (frequencydomain approach), indirect method (time domain approach). This can also be categorized based on parametric and non-parametric (periodogram) methods.

Among the various methods available for spectrum sensing, cyclostationary detection is dealt in this paper. This technique requires prior knowledge of the primary signal whose principle concept involves Fourier transform of the signal received (Ali *et al*,2012). Here we assume Multiband OFDM to be the transmitter. The received signal is given by

$$Z(t) = x(t) + n(t) \qquad (1)$$

Where x (t) is the transmitted signal. n(t) is the noise signal in the channel. The signal is correlated over a certain time period T (Yonghong Zeng and Ying-Chang Liang, 2010). In order to eliminate the discontinuities among the waveform the signal is then smoothened using windows. Finally the integrated signal is compared against a threshold value to finalize the existence of the primary user. If the primary user is present then we can

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find the features of the primary signal such as operating frequency and modulation technique(Yucek and Arslan,2009).

Although the energy detection technique is regarded as the easiest one, it involves analysis of the received signal to determine the presence of the primary users (Paisana*et al*,2012). The primary signal is said to be present if the received signal exceeds a certain threshold.This situation indicates the spectrum being occupied. The primary user isunavailable if the received signal is less than the predetermined threshold and the secondary user can gain access to the temporarily free spectrum. This decision can be made on the following hypotheses

H0: signal is absent = n(t) (only noise)

H1: signal is present= s(t) + n(t) (signal + noise)

An efficient wavelet technique has been employed unlike the traditional FFT method used in cyclostationary detection method. Due to its ability to provide both time and frequency representation simultaneously, wavelet transform has gained prominent importance in the recent years. FFT can provide only spectral information of the stationary signal (Avila and Thenmozhi, 2012).Coiflet,one of the wavelet families possessing symmetric characteristic, has been implemented in this paper.

A number of parameters such as threshold used,noise levels and number of users/inputs available affect the success of the spectrum sensing method.Multiple antennas can be utilized to improve this success rate.A comparator can be employed to compare the signals from each of the antennas against the predetermined threshold. This can result in the reduction of the probability of missed detection or false alarm.

The existing amplifiers and ADC architecture become very tedious in processing the huge UWB spectrum. Hence the entire spectrum of UWB is divided into 5 master groups with 3 sub bands in each of the first 4 master groups while the 5th master group has only 2 sub bands. This result in 14 sub bands,each occupying a bandwidth of 528MHz. OFDM technique is implemented in each sub band.Hence the name multiband OFDM. Of the 128 subcarriers, 100 are allotted for data transmission, 12 for piloting requirement, and 10 as guard tones. A subcarrier spacing of 4.125 MHz is allocated. Frequency hopping is done within the group (AnujBatra*et al*,2006;JaiganeshBalakrishnan*et al*, 2003).

In this paper multiband OFDM is modeled as cognitive radio and specifically for the spectrum sensing purpose of the free holescyclostationary method has been implemented. Remaining part of the research contribution is planned as follows. Section II concentrates on the proposed methodology and section III deals with results and discussion. Section IV concludes the paper.

Proposed System Model:

The MB-OFDM system is shown in Fig. 1.

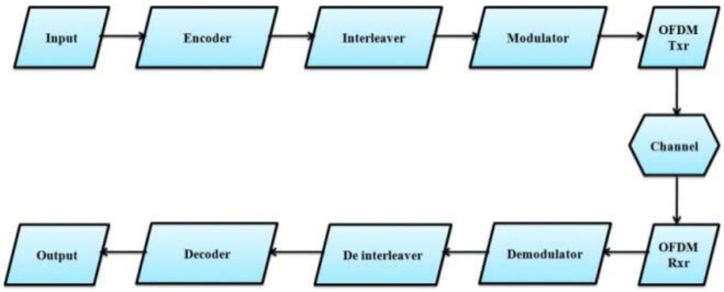

Fig. 1: Block diagram of MB-OFDM system

The initialstages of the block incorporate a scrambler to randomize the input data. This scrambled data is fed to the next stage to be encoded by a convolutional encoder. This consists of shift registers that convolve thedata fed with that of a predefined impulse response.The code rate, a characteristic of any convolutional encoder, is given by the ratio k/n where n is the number of coded bitsand k is the input bit. Here we utilize a ½ encoder,i.e.,For each input two encoded bits are available. The impulse response is given by G1 (111) and G2(101). We use the conventional Viterbi algorithm decoder which utilizes path metrics to analyze the most likely path involved with the transmitted data. This algorithm is carried by dividing the Ml+1 possible sequence into M^l groups. The sequences with highest probability are chosen from the M sequences (Avila *et al*,2012).

Proceeding further with the block stages we arrive at an interleaver, that provides robustness against burst error.Thisstage is followed by QAM modulation. The QAM modulated signal is given by(Bernard Sklar and Pabitra Kumar Ray, 2001)

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$$y(t) = y_0(t)\sqrt{D}\cos(2\pi f_0 t)$$
$$+ y_e(t)\sqrt{D}\sin(2\pi f_0 t)$$

Where (2)

D=amplitude of the signal
$y_o(t)$ = odd number sequence
$y_e(t)$ = even number sequence

This signal y(t) is then passed through an inverse wavelet transform block where they are converted to OFDM symbols.The OFDM symbols are then transmitted over the channel with Additive White Gaussian Noise characteristics.At the receiver side the Fast Fourier Transform part of the cyclostationary method is replaced with wavelet transform(Bikramaditya Das*et al*,2011). Due to its capability to offer a multi resolution for non stationary signals and its ability to provide time and frequency domain transform, it has been used extensively for analysis. A window has also been utilized that provides smoothness to the signal, reducing the spectral leakage in both the side lobes without any truncation. Kaiser window has been incorporated in this research work.This signal is then correlated and averaged over the time period T. A final threshold detector is used to detect the signal in the final stage.

RESULTS AND DISCUSSION

Matlabhas been used to plot the results. The performance metrics are signal to noise ratio (SNR) versus Probability of detection (P_d).

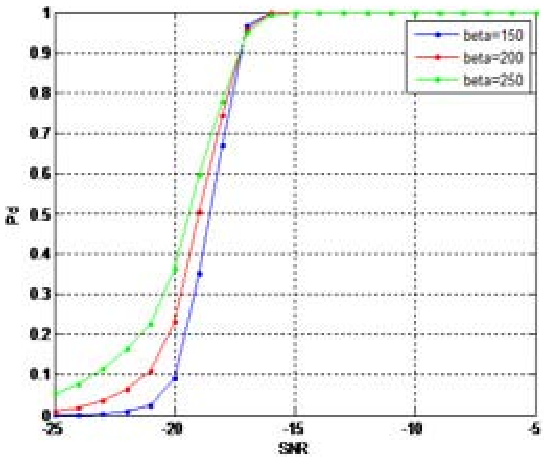

Fig. 2: Comparison between various values of beta

Figure 2 gives an analysis between various beta values of Kaiser Window. Beta defines the attenuation of sidelobes. From the figure it is evident that as the value of beta increases sidelobes are attenuated. As a consequence probability of detection increases so that we are able to detect the presence or absence of primary users at the earliest.

Figure 3 gives comparison between various window sizes of Hanning window. As the window size increases, better results could be achieved. For the given SNR of -20dB there is a significant improvement in the probability of detection which in turn reduces the sensing time.

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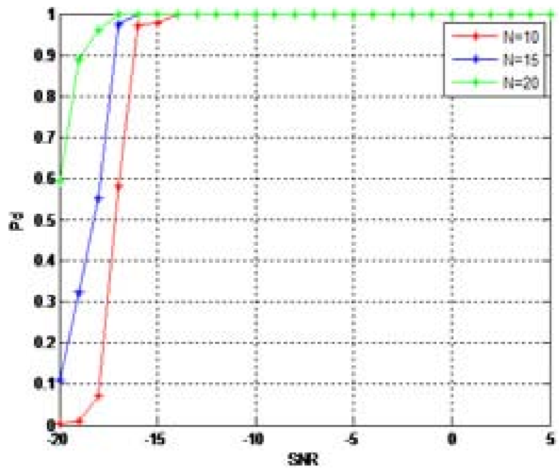

Fig. 3: comparisons of various window sizes of Hanning window

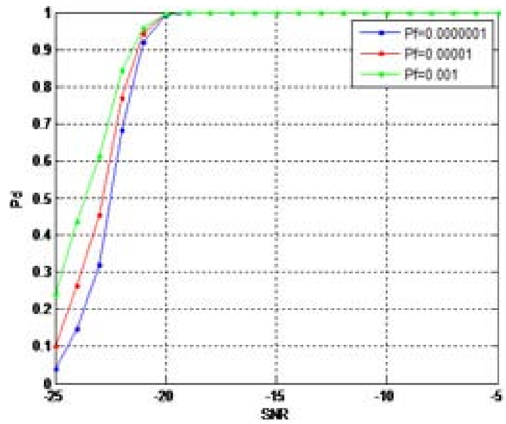

Fig. 4: Comparison between different values of P_f

Figure 4 gives a relative study between various values of probability of false alarm. The results are plotted for P_f values of .001,.00001,.0000001.From the figure it isclear that as the value of P_f decreases the degradation of system performance decreases which in turn makes the probability of detection an easier task.

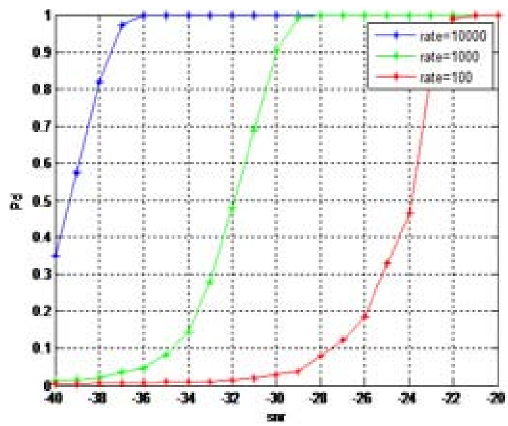

Fig. 5: Comparison between various data rates

Figure 5 shows a comparison among various data rates of the Multiband OFDM transmitter. As the data rate increases better results could be achieved because more information is available to sense the presence of the primary user.

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Conclusion:

With an ever increasing demand in the available spectrum, cognitive radio technique provides an efficient utilisation of the spectrum.In real time systems, spectrum sensing is a challenging task as it involves steps to mitigate interference with the primary signal. In our research paper a cyclostationary based spectrum sensing by treating Multiband OFDM system as a cognitive radio is considered and its performance is analyzed. Unlike the conventional FFT technique we have employed wavelet transform block and in addition a comparative study with energy detection technique is performed.Multipath propagationcooperative based spectrum sensing is used to overcome the issues of shadowing and this has resulted in an improved detection performance due to spatial diversity.

REFERENCES

Ali, O., F. Nasir and A.A. Tahir, 2011. Analysis of OFDM parameters using Cyclostationary spectrum sensing in cognitive radio.Multitopic*Conference* (INMIC).*IEEE 14th International*, pp: 301-305.

Ali, R., A. Ahmad, B. Hussain, N. Zarin, I. Khan and I.A. Khan, 2012. Cooperative cognitive network: Performance analysis of Cyclostationary spectrum detection.*International conference on Emerging Technologies* (ICET), pp: 1-5.

Anuj Batra, Srinivas Lingam and Jaiganesh Balakrishnan, 2006. Multiband OFDM: A cognitive radio for UWB. *Proceedings of International symposium on circuits and system*, pp: 4094-4097.

Avila, J and K. Thenmozhi, 2012.Wavelet supersede FFT in MB-OFDM: an Effective cognitive spectrum sensing.*Journal of Artificial intelligence*., 5(3): 113-121.

Avila, J., E. Vinoth and K. Thenmozhi, 2012. Anti-Interference for Anti-Corrupt 3G Spectrum-A Multi Carrier Approach.*IEEE International conference of computer communication and informatics* (ICCCI-12), pp: 1-4.

Bernard Sklar and Pabitra Kumar Ray, 2001. Digital communication-Fundamentals and applications, second edition, Pearson education.

Bikramaditya Das, SurykantTiwari and Susmita Das, 2011. Performance study of discrete wavelet packet based MB-OFDM system for short range indoor wireless environment. *IEEE International conference on devices and communication* (ICDeCOM), pp: 1-5.

Haykin, S., 2005. Cognitive radio: Brain empowered wireless communications. *IEEE Journal on selected areas in communications*., 23(2): 201-220.

Jaiganeshbalakrishnan, AnujBatra and Anand Dabak, 2003. A multiband OFDM system for UWB communication.*IEEE conference on ultrawide band systems and technology*, pp: 354-358.

Jian Chen, A. Gibson and J. Zafar, 2008. Cyclostationary spectrum detection in cognitive radios.*IET Seminar on Cognitive Radio and Software Defined Radios: Technologies and Techniques*, pp: 1-5.

Mitola, III, 2000. Cognitive Radio.-An Integrated Architecture for Software Defined Radio.Ph. D.Thesis, Royal Institute of Technology, Sweden.

Paisana, F., N. Prasad, A. Rodrigues and R. Prasad, 2012. An alternative implementation of a cyclostationary detector.15th*International Symposium on Wireless Personal Multimedia* Communications (WPMC), pp: 45-49.

Yonghong Zeng and Ying-Chang Liang, 2010. Robustness of the cyclostationary detection to cyclic frequency mismatch. *IEEE 21st International Symposium on Personal Indoor and Mobile Radio Communications* (PIMRC), pp: 2704-2709.

Yucek, T. and H. Arslan, 2009.A survey of spectrum sensing algorithms for cognitive radio applications.*Communications Surveys & Tutorials*, IEEE, 11(1): 116-130.