Spectrum Sensing Algorithms for Orthogonal Frequency Division Multiplexing Framework

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The growth and quality of service in wireless applications depends on the availability of the spectrum.The unused spectrum need to utilize in an efficient manner to support the several application of radio frame work.In this work we focused to simulate spectrum sensing algorithm. The detection algorithms namely Energy detection (ED), Matched filter and Geortzel algorithm is applied to the OFDM framework and the performance is analysed using Matlab-2014. Further, the probability of detection is estimated and compared for different algorithms.The projected method estimate the availability of spectrum in presence and absent of primary user.however high SNR for detection is seen is a major constraints in ED.

Keywords: ED, OFDM, Cognitive Radio, Spectrum.

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1 Introduction

Spectrum detection without interference is the main objective of Cognitive Radio (CR).CR function is based on software defined radio(SDR) which identifies the idle spectrum from primary user(PU) and allocate the resources to the secondary user (SU). Although, efficiency of spectrum detection algorithms reduces noisy environment and unstable channel. To overcome this constraint several method detection are proposed[1]. The detection of PU is estimated by comparing the energy of received signal with predetermined threshold value. If output energy of received signal exceeds the threshold value we assume the signal detection. In some cases the noise ismisrepresented as signal which is known as false alarm rate. ED is simple and efficient method of determining the spectrum noise.However requirement of high SNR is one of the constraints in implementation of ED [2]. In this work Ed is applied on the OFDMA system and parameters like probability of detection, false alarm and BER estimated. In[2] the challenges of the Cr was discussed and comprehensively studied. Further the implementation of spectrum detection algorithms were analysed with several parameters such as pd, pfa and BER. The author [3] pdf studied the existense work on cognitive radio. It is seen that the main task of spectrum sensing algorithms is to detect the primary user without any disturbance further the main constraints of CR such as interference, cooperative spectrum detection and gain were studied and solutions were also given. In[4] the role of spectrum sensing algorithms Internet of things (IoT) and cellular radio subsystem were investigated and analysed. The proposed work focused on the new challenges in rollout of spectrum algorithms in advanced radio network. In [5] energy detection algorithm was implemented in AWGN challenge for different transmission method. The simulation outcome reveals that the detection of spectrum increases with increase of false alarm and QAM scheme gives best performance a compared with other algorithms. In [6] an advanced pattern recognization algorithms were implemented to sense the availability of unused spectrum. The projected algorithm was based on linear and polynomial technique. It is observed that the efficiency of detection algorithm enhanced by increasing ht number of users. The work in[7] overview the challenges,implementation and overview of cognitive radio it is observed that the scarcity of spectrum can be solve by implementing a dynamic bandwidth access algorithm. However there are several constraints such as interference channel condition that may affect the performance of system. In thos paper, spectrum sensing algorithms such as ED,matched filter andGeortzel method were studied for OFDMA frame work.

2 System Model

The structure of OFDMA is shown in figure1. OFDMA is designed by using Fourier Transform, Cyclic Prefix(CP).

The OFDM signalis given as [8]:

$$r(t) = \sum_{n=-\infty}^{n=\infty} r_m(t - nT) \qquad (1)$$

The symbols are modulated with m subchannels are such by

$$r_n(-1) = \sum_{m=0}^{k-1} s_{n,k} \exp(j2\pi k \Delta f(t))\, f(t) \qquad (2)$$

where f(t) is the response of filter and $s_{n,k}$ is the composite signal. The received OFDMA signal is given by:

$$R_m(k) = \frac{1}{M} \sum_{m=0}^{k-1} r_m W_M^{mk} \qquad (3)$$

Finally, if the energy of $R_m(k)$ is greater than threshold value the signal is determined. The ED structure is given in fig.2 [9].

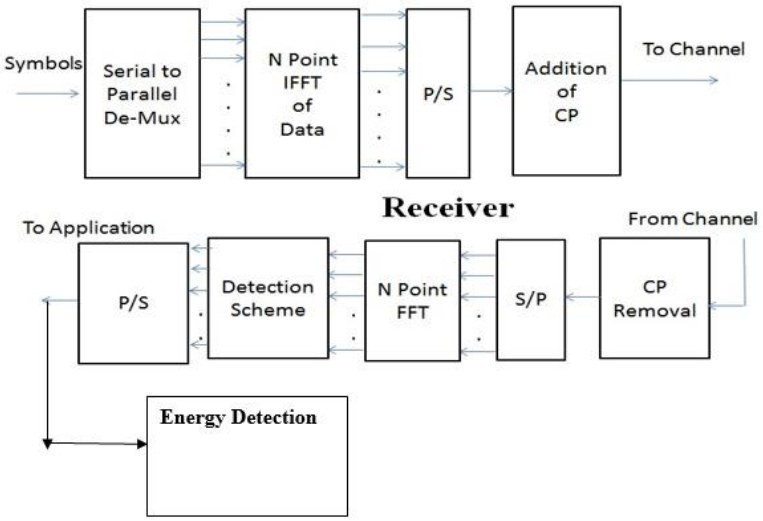

Fig.1. Schematic of OFDM structure

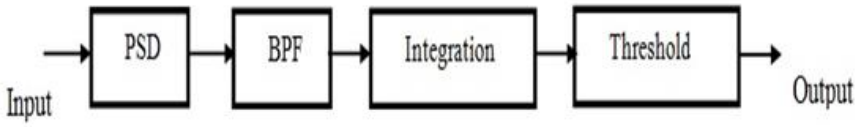

Fig.2. Energy detecton structure

3 Simulation Results

The projected system is designed on MATLAB 2014. The simulation parameters are given in table.

Table 1. Parameter

S. No	Parameters
1	OFDMA system
2	QAM-16
3	Subcarrier=64
4	FFT=64

We proposed a spectrum detection algorithm for OFDM. The performance of mathematical mode of several detection algorithms were applied and performance was estimated. It is also seen that the

complexity of system increased with detection performance. The probability of detection of Ed on OFDMA structure is given in fig. 3. The maximum detection is obtained at SNR of-16dB. Hence,it is noticed that the performance of Ed is enhanced in the projected work. However, the requirement of SNR is high in Ed, which needs to be improved. The matched filter spectrum algorithm is applied on OFDMA structure given in fig.4. The detection is accomplished at the SNR of -35dB. It is seen that the matched filter is robust to noise but need a prior knowledge of the channel. However, the high SNR problem of ED is overcome in matched filter. TheGeortzial algorithm is applied to the OFDMA structure. The detection is obtained at SNR of -30dB given in fig.5. However, it is noted that the design of Geortzel algorithm is complex as compared with existed algorithms.

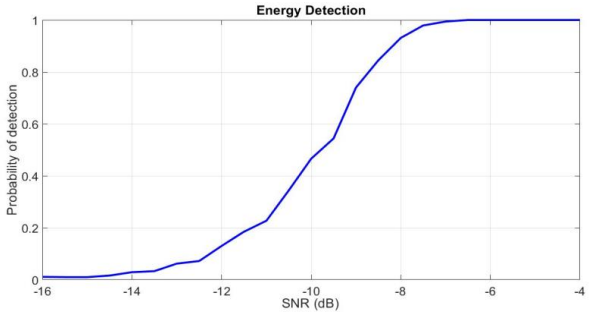

Fig.3. Pd Vs SNR for ED

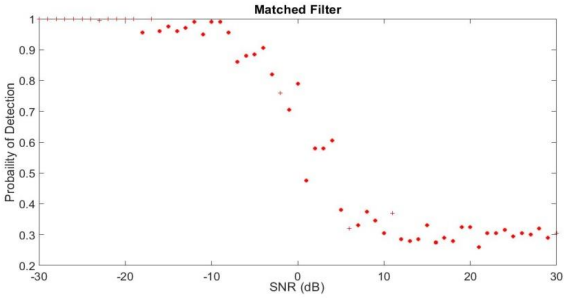

Fig.4. Pd Vs SNR for Matched filter

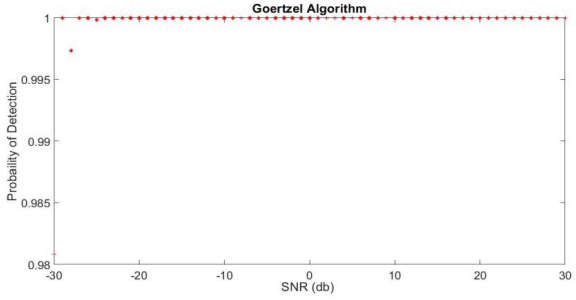

Fig.5. Pd Vs SNR for Goertzel algorithm

4 Conclusion

Spectrum sensing will play a significant role in the forthcoming wireless radio framework. The unused spectrum is utilized by implementing CR. In this work,the spectrum sensing algorithm is detected byutilizing several algorithm. The outcome of work reveals that the performance of ED increases with increase in SNR. Further, It is also seen that the matched filter obtained an optimal performance. However, the design of matchedfilter and Geortzelis complex as compared with ED. In future, the hybrd algorithm which is a combination of ED and matched filter is suggested to overcome the complexity constraints of detection methods. Further, the conventional algorithms can be modified for the advanced waveforms.

References

[1]. K. Kockaya and I. Develi, "Spectrum sensing in cognitive radio networks: threshold optimization and analysis", *J. Wireless Com. Network,* vol. 2020, 255, 2020.

[2]. N. Muchandi and R. Khanai, "Cognitive radio spectrum sensing: A survey," in the *Int. Conf. on Electrical, Electronics, and Optimization Techniques*, 2016, pp. 3233-3237.

[3]. I. F. Akyildiz, B. F. Lo and R. K. Balakrishnan, "Cooperative spectrum sensing in cognitive radio networks: A survey", *Phy. Commun.*, vol. 4, no. 1, pp. 40–62, 2011.

[4]. A. Nasser et al., "Spectrum Sensing for Cognitive Radio: Recent Advances andmFuture Challenge", *Sensors,* vol. 21, no. 7, 2408, 2021.

[5]. A. Ranjan, Anurag and B. Singh, "Design and analysis of spectrum sensing in cognitive radio based on energy detection," in the *Int. Conf. on Signal and Inform. Proce.*, 2016, pp. 1-5.

[6]. Y. Hassan, M. E. Tarhuni and K. Assaleh, "Learning-Based Spectrum Sensing for Cognitive Radio Systems", *J. Comp. Networks and Commun.*, vol. 2012, Article ID 259824, 13 pages, 2012.

[7]. G. T. Bharathy, V. Rajendran, T. Tamilselvi and M. Meena, "A Study and Simulation of Spectrum Sensing Schemes for Cognitive Radio Networks," in the *7th Int. Con. on Smart Struct. and Systems*, 2020, pp. 1-11.

[8]. S. Hussin, K. Puntsri and R. Noe, "Efficiency Enhancement of RF-Pilot-Based Phase Noise Compensation for Coherent Optical OFDM Systems", in the *17th Int. OFDM Workshop,* 2012, pp. 1-5.

[9]. P. Nandhakumar and Arunkumar, "Analysis of OFDM System with Energy Detection Spectrum Sensing", *Indian J. Sci. and Tech.*, vol. 9, no. 16, pp. 1-6, 2016.