A Smart Spectrum Sensing in Cognitive Radio Using Cyclo-Energy Technique

Mr. Gaikwad Yogesh S, Dr. Kharat Govind U, Mr. Rahul S Bansode

***Abstract*— this paper presents novel method of spectrum sensing using cyclo-energy technique. There are specific advantages and disadvantages of cyclostationary spectrum sensing technique and energy spectrum sensing technique. The proposed method combines advantages of both the techniques in effective manner. It also eliminates drawbacks of respective existing techniques. The proposed system can be called as hybrid spectrum sensing technique. Due to scarcity of spectrum, it is important to do spectrum management. Spectrum management will allow more number of users to utilize existing spectrum effectively. This concept is implemented using cognitive radio. Cognitive radio classifies licensed users in to primary and secondary users. Primary user has first priority to access spectrum .And secondary user has second priority to access spectrum only at absence of primary user. Spectrum sensing and spectrum allocation are two important things in cognitive radio. Existing Spectrum sensing techniques has some drawbacks. These drawbacks are overcome using proposed cyclo-energy technique. For spectrum allocation hard decision rule is used. Here AND rule is used as a hard decision rule. Rayleigh channel is used as a communication medium. Efficiency of proposed technique is verified using probability of detection, probability of false alarm and probability of miss detection. The proposed system is found to be efficient and effective. The system is verified against intruders also. The proposed system successfully restricts intruders to accommodate channel. The proposed system found to be more efficient for spectrum sensing and spectrum allocation as compared to existing methods.**

***Keywords*—** *Cyclo-energy technique, probability of detection, probability of false alarm, probability of miss detection, AND rule.*

I. INTRODUCTION

Globalization has big impact over the world. Digitization has increased over the years. With digitization communication usage has been drastically increased. Increased demand in mobile phones and many other such services has changed the demand of spectrum management. Because of new technological innovations in network services such as 3G & 4G, moreover sudden development of wireless internet services has wheeled the demand of wireless broadband. In recent years, there has been drastic revolution in wireless communication service market globally. Therefore, as users of the spectrum are increasing, the problems are growing. The natural frequency spectrum has limitation as the present static frequency allocation system cannot accommodate increased consumers for higher data rate devices. Consequently, new methods of developments and innovative technologies of spectrum are needed to be made available. The spectrum congestion problem can be solved by cognitive radio technique through introducing opportunistic usage of the frequency bands that are not heavily occupied by licensed users. Spectrum sensing is defined as the task of finding of spectrum holes by sensing the radio spectrum in the local neighbourhood of the cognitive radio receiver in unsupervised manner. The spectrum holes stands for those sub bands of the radio spectrum that are underutilized at particular instant of time and specific geographic location. Spectrum Sensing is the capability to determine and sense whether license user is present or absent. Objective of cognitive radio is that unlicensed user needs to detect the presence of licensed user or shift to another frequency band or stay in the same band by changing its modulation scheme to avoid interference. Spectrum Sensing involves the detection of the presence of a transmitted signal, by a given Receiver. The ability of a cognitive Radio to dynamically access the spectrum holes that dynamically appear is predicated upon its ability to detect these white spaces in the first place.

A CR is designed to be aware of and sensitive to the changes in its surroundings, which makes spectrum sensing an important requirement for the realization of CR networks. Spectrum sensing enables CR users to adapt to the environment by detecting spectrum. The proposed system is an implementation of Cyclo-energy hybrid technique of spectrum sensing. AND rule is used for spectrum allocation. MATLAB is used as software for implementation.

II. PAPER SURVEY

The paper named as ‘Cognitive Radio Networking and Communications: An Overview’, authored by Ying-Chang Liang published in IEEE Transactions on Vehicular Technology, October 2011 states that “Cognitive radio (CR) is the enabling technology for supporting dynamic spectrum access: the policy that addresses the spectrum scarcity problem that is encountered in many countries. In this paper, we provide a systematic overview on CR networking and communications by looking at the key functions of the physical (PHY), medium access control (MAC), and network layers involved in a CR design and how these layers are crossly related.In the network layer, cognitive radio network (CRN) tomography, spectrum-aware routing, and quality-of service (QoS) control will be addressed [1].

The paper named as 'An Overview of Cognitive Radio Networks', authored by Sachitha Kusaladharma published in International Conference on Communications Workshops. IEEE, 2009, pp. 1–5. States that "Radio spectrum needed for applications, such as mobile telephony, digital video broadcasting (DVB), wireless local area networks (WiFi), wireless sensor networks (ZigBee), and Internet of things, is enormous and continues to grow (1,2,3). This exponential growth is set to continue (4). For example, by 2019, the monthly mobile data traffic will exceed 24.3 exabytes, mobile devices per capita will be 1.5 and the average speed of a wireless connection will increase to 4 Mbps, over 59% of mobile connections will be from smartphones, and mobile-to-mobile connections will be the majority (4). Therefore, the demand for wireless connectivity, coverage, capacity, and services will continually expand. The prime spectrum for current wireless standards may be roughly 1–5 GHz. This is because the spectrum below 1 GHz has already been reserved for applications such as radar, military communications, and terrestrial radio/television, while the spectrum above 5 GHz suffers from increased attenuation and atmospheric absorption. Therefore, the limited spectrum presents a roadblock for the rapid growth of wireless networks and users" [2].

The paper named as 'Cognitive Radio Principles and Spectrum Sensing' authored by J. Divyalakshmi, Rangaiah. L published in International Journal of Engineering and Advanced Technology (IJEAT), states that "Cognitive Radio is an all intelligent radio network that is advancement over the conventional radio. The major advantage of the cognitive radio is that it can detect channels that are available from the spectrum and modify the parameters used for transmission so that the several unused frequencies can be used concurrently. This paper details the sensing and interference mechanisms of the cognitive radio and explains how and why the cognitive setup is far excellent compared to the conventional radios. There are numerous technologies used in the cognitive radio setup such as the Adaptive radio and Software Defined Radio (SDR). The applications of the findings of this paper can be extended to cognitive radio design and implementation" [3].

The paper named as 'A Survey on Spectrum Management in Cognitive Radio Networks' authored by Ian F. Akyildiz published in IEEE Communications Magazine • April 2008, states that "Cognitive radio networks will provide high bandwidth to mobile users via heterogeneous wireless architectures and dynamic spectrum access techniques. However, CR networks impose challenges due to the fluctuating nature of the available spectrum, as well as the diverse QoS requirements of various applications. Spectrum management functions can address these challenges for the realization of this new network paradigm. To provide a better understanding of CR networks, this article presents recent developments and open research issues in spectrum management in CR networks. More specifically, the discussion is focused on the development of CR networks that require no modification of existing networks' [4].

The paper named as 'Handover Based Spectrum Allocation In Cognitive Radio Networks' authored by Suganya.M, published in IEEE 2013 states that "There is a rapid development in wireless technologies with the increase of congestible frequency spectrums, research study reveals that there is a problem in spectrum management and spectrum allocation. To overcome this problem there is a new technology known as cognitive radio technology in wireless sensor networks called as CWSNs. The first standard for cognitive radio networks is IEEE 802.22, but this standard cannot overcome the problem of spectrum management and spectrum allocation. In this paper we propose a novel protocol in which spectrum allocation can be done by increasing the transmission range and communication quality, lowering the energy consumption and delays" [5].

The paper named as 'A study of recent trends in cognitive radio communications and networks for licence free connectivity ' authored by Jitendra Jangir published in IJERT Conference Paper · February 2014. It states that "In recent trend all the organization wants connectivity by utilization of unlicensed spectrum as a medium for inexpensive connectivity in rural/remote areas and innovation by serving as a barrier-free and cost-effective platform for testing and implementing of new technologies. Wide and dynamic spectrum is available to make radios and wireless networks truly cognitive, however, is by no means a simple task, and it requires collaborative effort from various research communities, including communications theory, networking engineering, signal processing, game theory, software-hardware joint design, and reconfigurable antenna and radio-frequency design. Cognitive radio (CR) is the enabling technology for supporting dynamic spectrum access the policy that addresses the spectrum scarcity problem that is encountered in many like signal processing techniques for spectrum sensing, cooperative spectrum sensing, and transceiver design for cognitive spectrum access with design and consideration for quality-of-service [6].

III. SYSTEM DEVELOPMENT

Figure.1 illustrates proposed system of hybrid cyclo-energy technique.

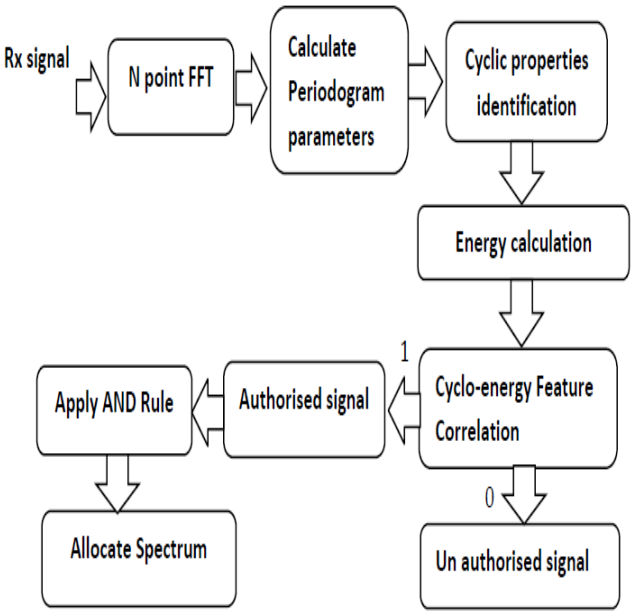

Figure. 1 Proposed system

As shown in figure.1 Spectrum sensing and allocation is based on the concept of a correlation. At cyclo-energy algorithm cyclic as well as energy properties of primary and secondary users are pre calculated and stored as a template. This template is correlated with real time signal. In case of successful auto correlation a signal is authorized to occupy the spectrum. Otherwise it is restricted.

Same is provided in block diagram. First any time domain received signal is converted in to frequency domain signal using fast Fourier transform. Then periodogram of frequency domain signal is calculated. This periodogram gives us cyclic properties as well as peak amplitude value of a signal. As a principle component of a signal three major amplitude are selected for energy calculation. While specific instance at major amplitudes are selected as a cyclic properties. These combined cyclo-energy properties are correlated with each real time signal. If real time signal matches with template then it will be authorized signal otherwise considered as an un-authorized signal. Once signal is authorized using hard decision rule (AND rule) a signal is allocated at specific spectrum.

IV. RESULTS

As shown in figure.2 Number of users are proportional to probability of detection.

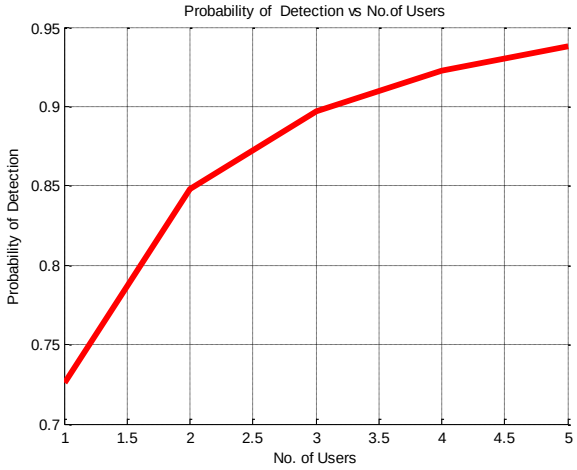

Figure.2

As shown in figure.3 Number of users are inversely proportional to probability of miss detection.

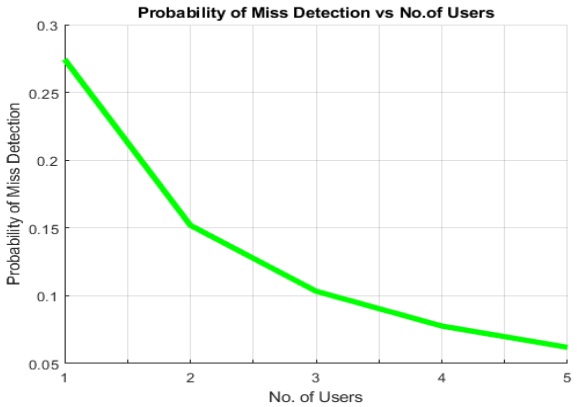

Figure.3

As shown in figure.4 probability of detection and signal to noise ratio are proportional to each other.

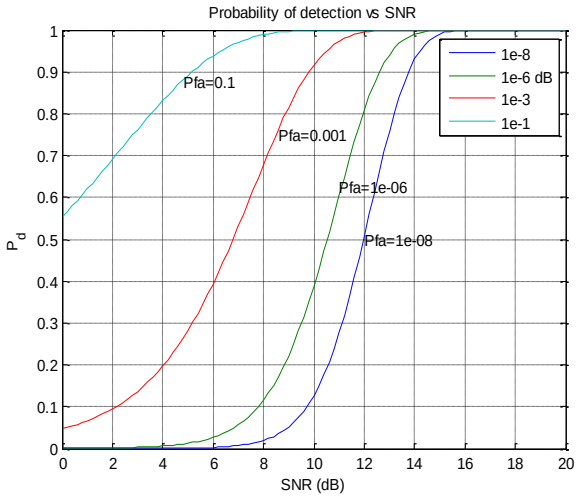

Figure.4

Also from figure.4 and 5, we can say that probability of false alarm and probability of detection are proportional to each other.

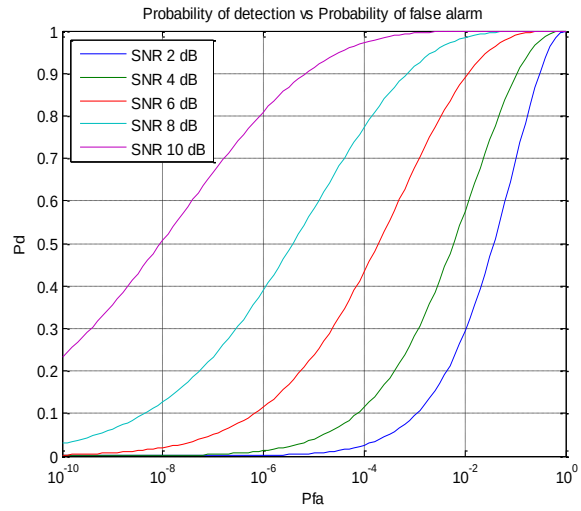

Figure.5

Figure. 6 Shows that probability of miss detection is inversely proportional to probability of false alarm.

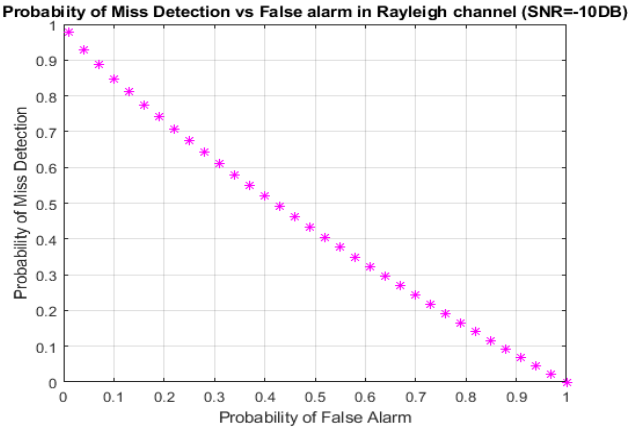

Figure. 6

V. CONCLUSION

We came to conclusion that cognitive radio helps to overcome radio spectrum scarcity by sensing spectrum utilization (irrespective of channel allocation), cognitive radios can broadcast on unused radio spectrum, while still avoiding interference with the operation of the primary licensee. It Avoid intentional radio jamming scenarios by sensing channel availability and even predicting the mummer's tactics, cognitive radios can evade jamming by dynamically and preemptively switching to higher quality channels. It Switch to power saving protocol by switching to protocols that trade off lower power consumption for lower bandwidth, cognitive radios conserves power. It Improves quality of service (QoS) By sensing environmental and inadvertent man-made radio interferences, cognitive radios can select frequency channels with a higher Signal to Noise Ratio (SNR). Spectrum sensing and spectrum allocation has various advantages. The proposed hybrid system has been found effective. It is verified using quality of service parameters.

REFERENCES

[1] R. C. Gonzalez and R. E. Woods, Digital Image Processing, 3rd ed. Upper Saddle River, *NJ: Prentice-Hall, 2007.*

[2] Shengfeng He, Qingxiong Yang, Member, IEEE, Rynson W.H. Lau, Senior Member, IEEE, and Ming-Hsuan Yang, Senior Member, *IEEE* "Fast Weighted Histograms for Bilateral Filtering and Nearest Neighbor Searching" *2015 IEEE.*

[3] Aruna.L ,S.S.Thamilselvi "Contrast Enhancement for Emissive Display Using Histogram Equalization and Bilateral Tone Adjustment*", International Journal of P2P Network Trends and Technology (IJPTT) - Volume3 Issue4- May 2013*

[4] Anan Du, Bin Li, Yecheng Zhang, Xiangchun Yu, Zhezhou Yu"A Novel Graph Construction Method Based on LocalitySensitive Histogram for Locality Preserving Projections",*Journal of Information & Computational Science 11:15 (2014) 5297{5304 October 10, 2014*

[5] J. Stark, "Adaptive image contrast enhancement using generalizations of histogram equalization," *IEEE Transaction on Image Processing,vol.9, no. 5, pp. 889–896, May 2000.*

[6] Z. Yu and C. Bajaj, "A fast and adaptive method for image contrast enhancement," in *IEEE ICIP, Oct. 2004, vol. 2, pp. 1001–1004.*

[7] A. Adams, J. Baek, and A. Davis. Fast high-dimensional filtering using the permutohedral lattice. *Computer Graphics Forum, 29(2):753–762, 2010.*

[8] A. Adams, N. Gelfand, J. Dolson, and M. Levoy. Gaussian KD-trees for fast high-dimensional filtering. *ACM TOG, 28(3), July 2009.*

[9] S. Bae, S. Paris, and F. Durand. Two-scale tone management for photographic look. *ACM TOG, 25:637–645, Jan. 2006.*

[10] S. Baker, D. Scharstein, J. Lewis, S. Roth, M. Black, and R. Szeliski.A database and evaluation methodology for optical flow. *IJCV, 92(1):1–31, 2011.*

[11] L. Bao, Q. Yang, and H. Jin. Fast edge-preserving patchmatch for large displacement optical flow. *IEEE TIP, 23(12):4996–5006, Dec 2014.*

[12] C. Barnes, E. Shechtman, A. Finkelstein, and D. Goldman. Patch- Match: A randomized correspondence algorithm for structural image editing. *ACM TOG, 28(3), Aug. 2009.*

[13] C. Barnes, E. Shechtman, D. Goldman, and A. Finkelstein. The generalized Patch Match correspondence algorithm. *In Proc. ECCV, Sept. 2010.*

First Author Mr. Yogesh S Gaikwad has done his Bachelor of Engineering in Electronics and telecommunication. Now he is pursuing his Masters of Engineering in Embedded and VLSI.
Email: yogeshg2u@gmail.com

Second Author Prof. Kharat Govind U has done his Bachelor of Engineering in Electronics and Masters of Engineering in Power systems. His PhD topic was power Electronics Now he is working as an Principal at Sharadchandra college of engineering, Otur, Maharashtra,India.
Email: principalspcoe09@gmail.com

Third Author Prof. Rahul S Bansode has done his Bachelor of Engineering In Electronics and telecommunication and Masters of Engineering in Embedded and VLSI. Now he is working as an Assistant professor at Sharadchandra college of engineering, Otur, Maharashtra,India.
Email: rahulbansodespcoe@gmail.com