iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** IV **Month of publication:** April 2018

DOI: http://doi.org/10.22214/ijraset.2018.4213

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com

Building Cognitive Radio

Raveena Jagtap[1], Sonam Desai[2], Hardik Bhanushali[3], Sameer Bhanushali[4], Prof. Pradnya Kamble[5]
[1, 2, 3, 4, 5] *K.J. Somaiya Institute of Engineering and IT, University of Mumbai, Mumbai.*

Abstract: Cognitive radio is a growing technology which has provided a better way for the efficiency of spectrum utilization. The explosion of wireless applications creates an ever-increasing demand for more radio spectrum. But due to static allocation these bands are considerably underutilized. This problem of underutilization can be solved by using a technology called as cognitive radio. Cognitive radio is a technology in which a device known as transceiver senses communication channel to find out which channel is occupied and which is vacant. The objective of cognitive radio is that it should not interfere with primary users and the band should be vacated when it is required. So in this paper we will see the performance of energy detection method and cyclostationary detection. The performance evaluation of energy detection and cyclostationary is done based on parameters like SNR and implementation complexity.

I. INTRODUCTION

Cognitive radio (CR) is a technology that allows secondary users (SUs) to sense the “spectrum holes” of the primary spectrum in the space, time and frequency domains and then make use of them in an opportunistic way on the premise of causing limited and tolerable interference to primary users (PUs)[1]. Spectrum holes defines that at a particular location the band of frequency allocated to a particular user at a time is now unused by that user. It avoids wasting spectrum that is allocated but unused at that time.

Cognitive radios (CR) which is a latest trend in wireless technology interacts with parameters of real time like carrier frequency, transmit power, modulation to adapt itself to the environment whenever there are statistical changes in the incoming radio frequency. The main purpose behind it is to take advantage of available spectrum without interfering with primary users[2].This makes the idea interesting because cognitive radio avoids wasting spectrum that is allocated to the user but is not used currently and thus saves spectrum.

The main steps of CR are as mentioned below:

1) Spectrum sensing
2) Spectrum management
3) Spectrum sharing
4) Spectrum allocation

Spectrum sensing is the process in which cognitive radio checks for presence of any primary users and detecting PUs spectrum holes. The detection of the best available channel out of all available channel is the method known as spectrum management. Allocation of frequency between the users is known as the Spectrum sharing between cognitive users. The technique of allocating channel to the primary user rapidly when it wants to retransmit again is known as spectrum allocation[3].

When primary users receive data in the communication range detection of spectrum holes is most efficient. For direct measurement between primary receiver and transmitter in a cognitive radio is difficult task. The spectrum sensing techniques can be classified as:

Non-cooperative detection :-In this type of spectrum sensing the cognitive radio acts on its own. It will prepare itself according to detected signals and information with which it is preloaded.

Cooperative detection :-Within a cognitive radio network sensing will be undertaken by a number of different radios. Various reports of signals from different number of radios in the network will be received by a central station and it will adjust the overall cognitive radio network to suit[3].

Spectrum sensing method used in CR communications is main element, it should be performed first before allowing any unlicensed user(SUs) to access an unused licensed spectrum of primary user. The basic nature of spectrum sensing are two-fold one is to ensure there is no interference between secondary user and primary user and two is to assist CR or secondary user to identify and use the spectrum holes present in the primary user band for the required quality of service (QoS).

The spectrum sensing operation used is a binary hypothesis-testing problem. The following two hypotheses are used:

P0: X(t) = N(t)

P1: X(t) = S(t)+N(t)

where, P0 denotes the absence of the primary user and P1 denotes the presence of the primary user. Here X(t) is the received signal, S(t) is the transmitted signal from the primary transmitter and N(t) is the Additive White Gaussian Noise (AWGN)[2]. To decide between the two hypotheses is the main goal of spectrum sensing.

II. SENSING TECHNIQUES

A. Energy Detection

Energy detection technique is the best detection technique as it does not require prior information about the primary signal. It will give the best results even at very low signal to noise ratio(SNR). Hence, we can perform spectrum sensing based on energy detection in presence of additive white Gaussian noise (AWGN) channel[4].

In the energy detection technique we apply energy detection at each CR. The energy detector consists of a square law device followed by a integrator. The output of the integrator over the time interval T is the energy of the input to the squaring device. The noise pre-filter present in the energy detector limits the noise bandwidth and noise at the input of the squaring device. It has a band-limited and flat spectral density

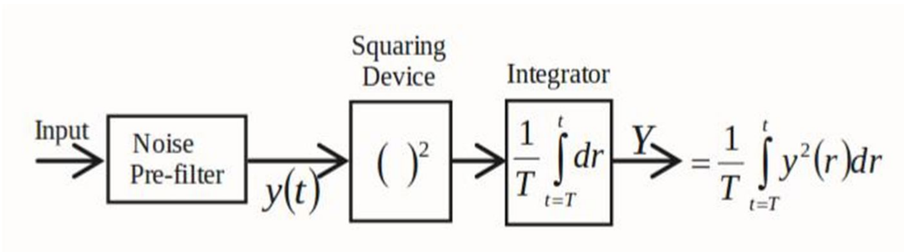


Fig. B : Energy Detector

B. Cyclostationary Detection

Generally any modulated signal includes some periodicity by definition and some pilots, preambles, cyclic prefixes, etc are added for synchronization or signaling purposes. It means autocorrelation of a signal exhibits an observable amount of periodicity. Cyclic correlation function is used instead of power spectral density and since noise is not correlated, this algorithm is able to differentiate noise from signals.

This method detects the presence of primary user by utilizing periodicity for detection of random signal i.e. noise. This algorithm is based on statistical approach which means an average has to be obtained and it requires time to provide output. More than one FFT calculation and correlation is involved in the process.

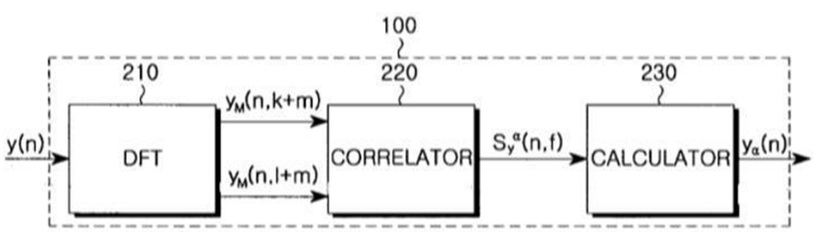


Fig. C: Cyclostationary Detection

C. Matched filter detection

Matched filter is an optimal detection process usually used in a case where a secondary user has a-priori knowledge of the primary user's signal [5]. The matched filter detection is achieved by performing correlation of a known signal or a template with an unknown signal for detecting the presence of the template signal's characteristics in the unknown signal. The advantage of matched filter detection is that it requires less time in achieving high processing gain because of coherent detection. However, matched filter detection has limited use currently because pre knowledge of the primary user's signal isn't expected to be known by the secondary users or cognitive radios. Apart from this, the need for cognitive radios or secondary users to have receivers for all signal types makes matched filter detection method uneconomical for implementation.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com

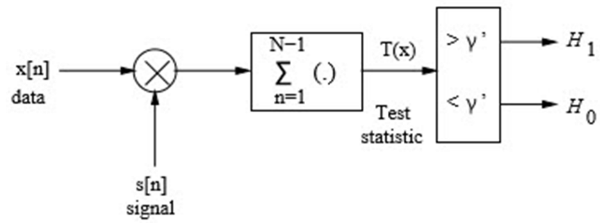
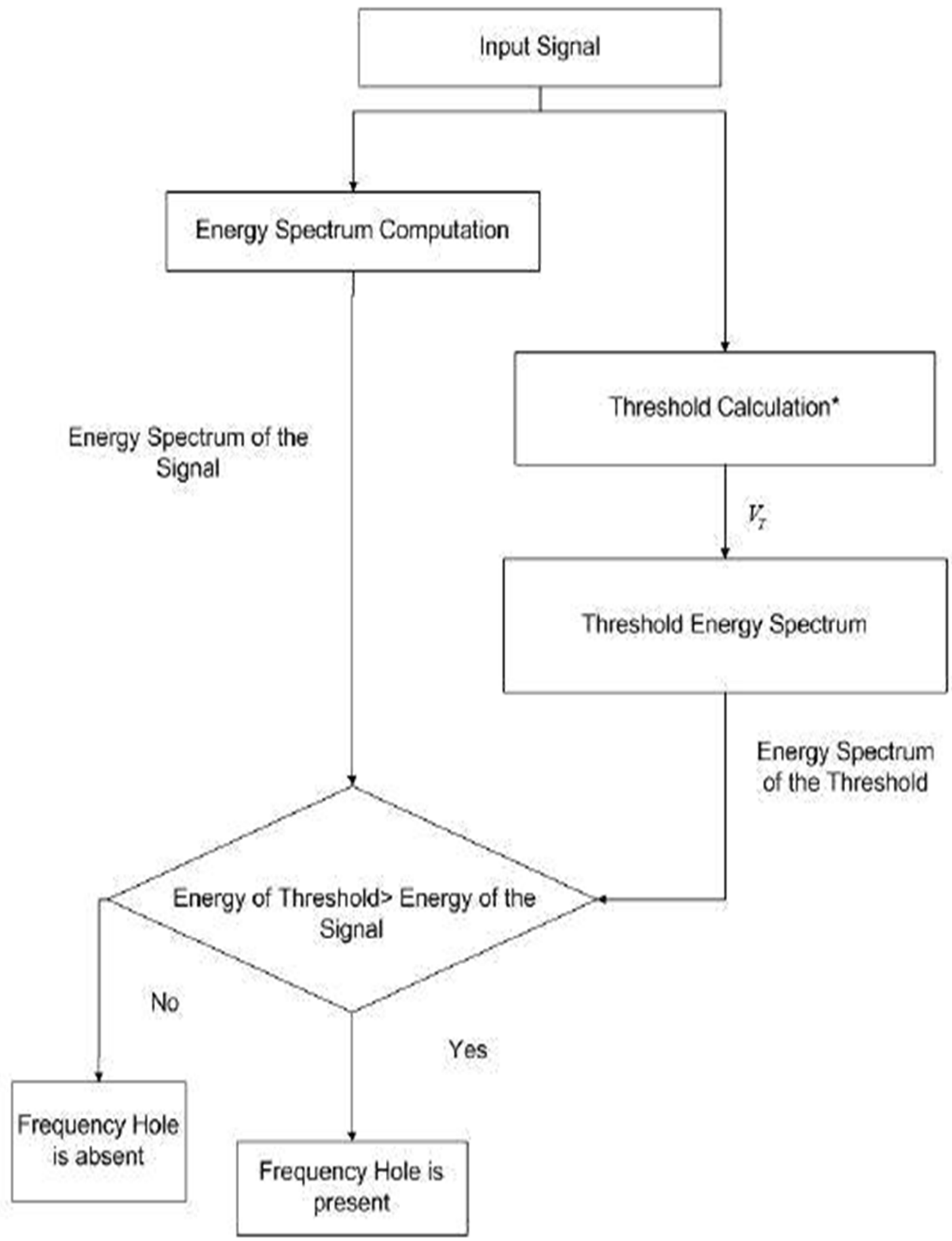


Fig. D: Matched filter Detection

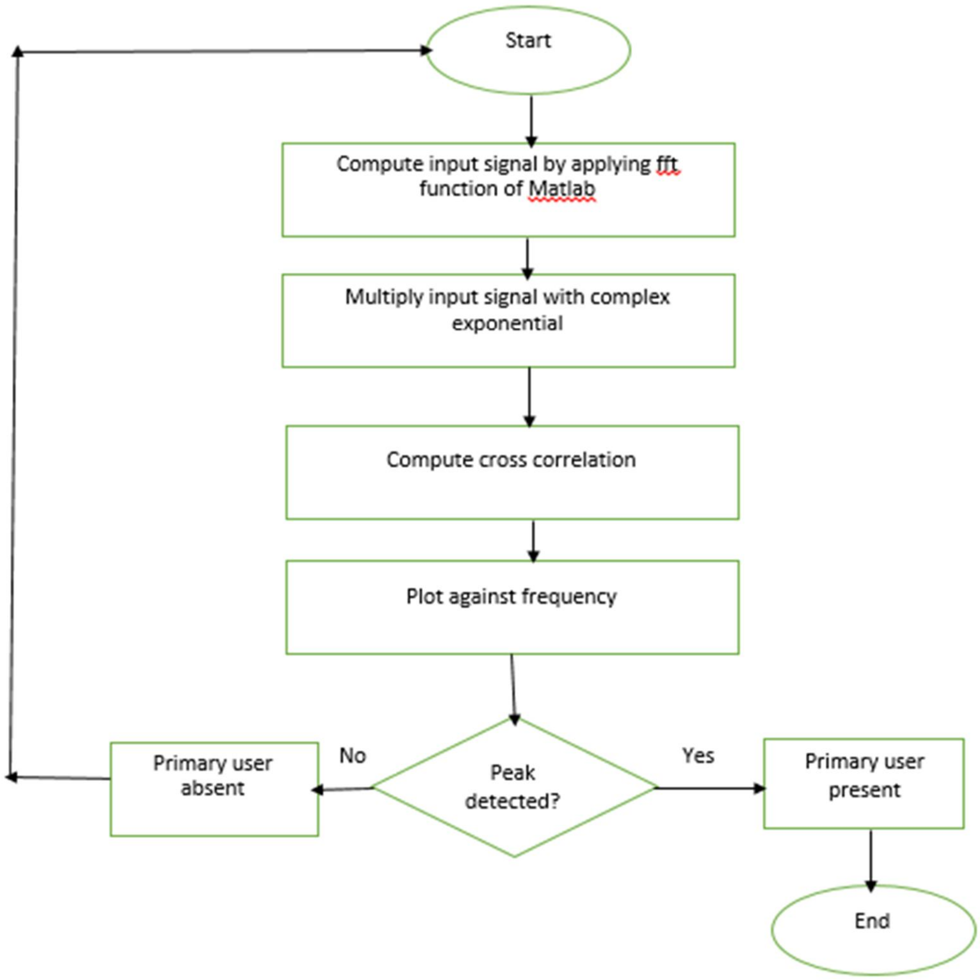
D. Conventional Energy Detection

Flowchart



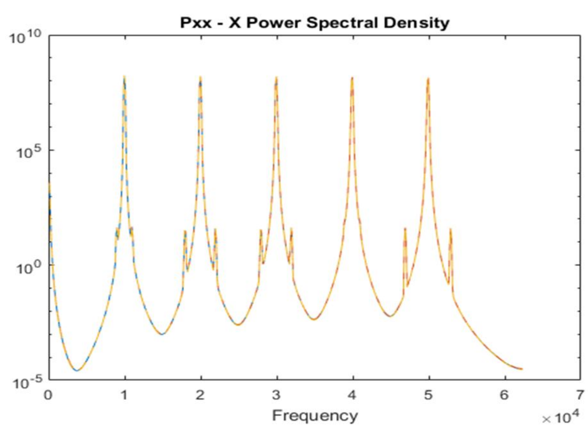
International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com

E. Conventional cyclostationary detection flowchart:

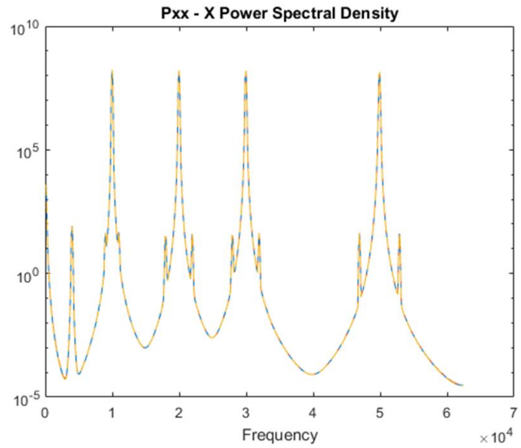


III. RESULTS

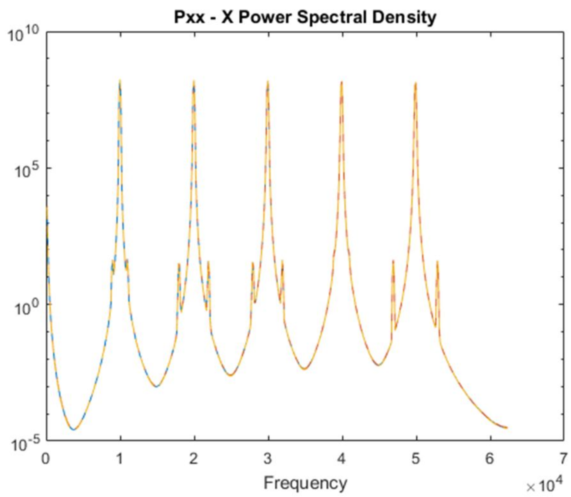
Energy detector measures the energy received from primary user during the observation interval. If energy is less then certain threshold value then it declares it as
spectrum hole. The cognitive radio system using spectrum sensing cognitive radios find out the spectrum holes and secondary users are allowed to use that spectrum holes as long as it does not interfere the primary (licensed) users. In this system five primary users are assumed. The carrier frequencies used for 5 signals are 1, 2, 3, 4 and 5 KHz respectively.



Case 1: All Primary Users Are Present



Case 2: Spectrum Hole Detected



Case 3: Secondary User Alloted Unused User

Cognitive radio continuously sense the radio environment for spectrum holes during communication but a CR can't sense and transmit at the same time. Thus we need sensing time as small as possible. Energy Detector requires a more sensing time to achieve proper results. Cyclostationary Feature Detection is a non coherent technique which makes it superior but computationally very complex due to which it takes long time for sensing. The major drawback of the energy detector is that it is unable to differentiate between primary user and noise . So this makes it receptive to uncertainties in background noise power, especially at low SNR. Cyclostationary Feature Detector is a better technique under noisy environment as it is able to distinguish between noise energy and signal energy. At low SNR cyclostationary is unable to detect primary user but energy detector still detect it. When primary user is absent even then energy detector detects primary user at low SNR, which makes energy detector an unreliable technique under low SNR values. On the other hand, the best technique is cyclostationary feature detection, when we have no prior knowledge about primary user's waveform.

IV. APPLICATIONS

CR can sense its environment and it can adapt to the user's communications needs without the intervention of the user. The amount of spectrum is infinite theoretically ; but practically, for propagation and other reasons its finite because of the desirability of certain portions of spectrum [4].Assigned spectrum isn't being fully utilized, and thus efficient use of spectrum is a growing concern. A cognitive radio can intelligently detect whether any portion of the spectrum is in use, and can temporarily use it without interfering with the transmissions of other users. Some other of the radio's cognitive abilities include changing frequency, determining its location, sensing spectrum use by neighboring devices adjusting output power or even altering transmission parameters and characteristics. All these capabilities will provide wireless spectrum users with the ability to adapt to real-time spectrum conditions, offering regulators, efficient and comprehensive use of the spectrum.[6]

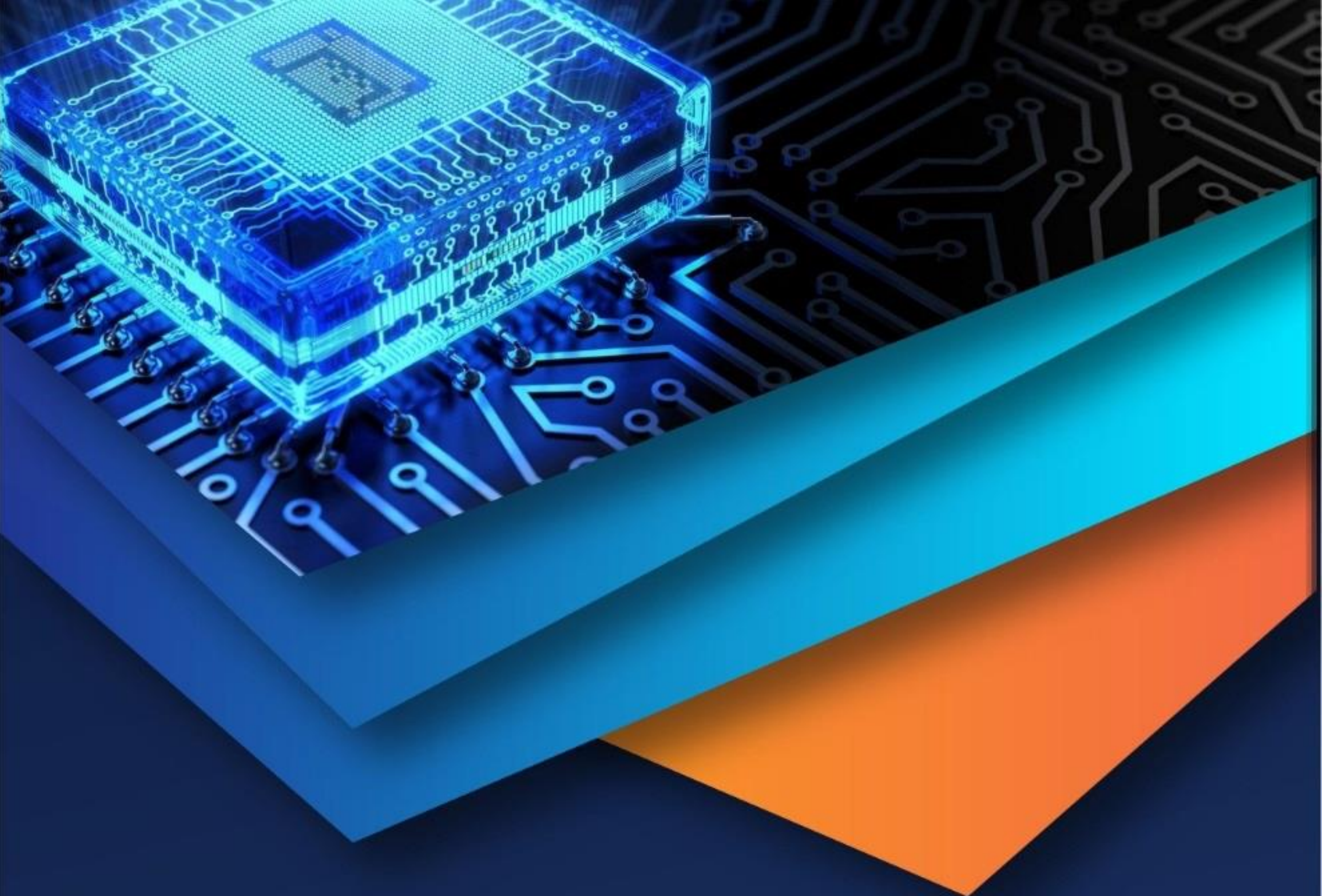
Some of the applications include:

1) The application of Cognitive radio networks to public safety communications and emergency by utilization of white space.
2) Cognitive radio networks can potentially execute dynamic spectrum access (DSA).
3) Application of Cognitive radio networks to military actions such as biological, chemical, nuclear and radiological attack detection and command control, investigation, battlefield surveillance, obtaining information on battle damage, intelligence assistance and targeting.

Mostly, the research on spectrum sensing is focused on reliable sensing for meeting the regulatory requirements. One of the important areas for the research is to focus on system level cooperation among different secondary users network and user level cooperation among cognitive radios and overcoming the uncertainties in noise level. Spectrum sensing is still a problem even though a lot of research has been done. Providing a reliable and rapid sensing results in all circumstantial cases is difficult .Drawbacks that still need to be looked at are identified: problems like sensing in low SNR, problem of hidden node, guarantee of QoS, challenges in wideband spectrum sensing and passive device detection. Another area for research is cross layer communication in which spectrum sensing and higher layer functionalities can help in improving quality of service (QoS).

REFERENCES

[1] J. Mitola III and G. Q. Maguire, Jr., “Cognitive radio: Making software radios more personal," IEEE Personal Communicatios Magazine, vol. 6, no. 4, pp. 13-18, Aug. 1999.
[2] Simon Haykin, “Cognitive Radio: Brain-Empowered Wire-less Communications”,IEEE journal on Selected Areas in Communications. vol. 23, February 2005.
[3] Ding Xu and Qun Li .”Cooperative Resource Allocation in Cognitive Radio Networks with Wireless Powered Primary Users” DOI 10.1109/LWC.2017.2727493, IEEE Wireless Communications Letters.
[4] Saqib Saleem and Khurram Shahzad, “Performance Evaluation of Energy Detection Based Spectrum Sensing Technique for Wireless Channel”, International Journal of Multidisciplinary Sciences and Engineering, Vol. 3,May 2012.
[5] J. Geetha Ramani.,Dr. K. Geetha,”Spectrum Sensing in Cognitive Radio using Energy Detection under Non Fading Environment”. International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169 Volume: 4 Issue: 3,30 – 32
[6] Salma Ibrahim AL haj Mustafa Amin Babiker A/Nabi Mustafa ‘Simulation of Cognitive Radio System Using Matlab” IOSR Journal of Electrical and Electronics Engineering ,Volume 10, Issue 3 Ver. I (May – Jun. 2015).



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY