ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

Cognitive Radio System Sensing using Swarm Intelligence

Anuja U. Patil, B. R. Pandurangi

M.Tech Student, Department of E&C, GIT, Udyambag, Belagavi, Karnatak, India

Professor, Department of E&C, GIT, Udyambag, Belagavi, Karnataka, India

ABSTRACT*:* Cognitive Radio Spectrum is an intelligent technique of accessing the spectrum to achieve optimization without harmful interference. It includes the phases like sensing the spectrum, managing it and spectrum sharing which are considered as an important function of CR [1]. Spectrum sensing is considered as an essential function that enables CR network to detect the primary users which are underutilizing the spectrum and allows the secondary users to use that unused spectrum for their use. There are some algorithms used for spectrum sensing, where in PSO (particle Swarm Optimization) technique is considered as an easy and the best among the other algorithms because of its less sensing time. Also it is energy efficient and evolutionary algorithm because of this, only few parameters needs to be adjusted as compared to other algorithms. By the use of PSO in spectrum sensing, spectrum allocation process can be enhanced by assigning it to the secondary users so that spectrum can be utilized efficiently.

KEYWORDS*:* Cognitive Radio System (CR), Radio Frequency Spectrum, Spectrum detection Techniques, Primary Users, PSO etc.

I. INTRODUCTION

Within the field of computer vision, object detection and tracking is an important task.Cognitive Radio spectrum is based on radio frequency spectrum and is recommended as a brilliant system that automatically detects the unused spectrum in wireless communication. It has an ability to alter the parameters according to sensed spectrum for transmission enabling more communication by achieving concurrent execution and also improves the radio operating characteristic [2].

Collaborative, Maintenance, Fault detection, self organized networks are the applications where cognitive radio network plays an important role [3].

The cognitive spectrum sensing algorithms allows CRN to discover primary users which are underutilizing the allocated spectrum. Upon detection that spectrum can be allocated to the secondary users for use. However, precisely detection of PU leads to longer sensing time and resulting in lower throughput. To overcome thedrawbacks of longer sensing time and lower throughput, PSO is utilized for the improvementation.

Our objective is to implement a model with PSO to put forward an energy efficient technique for spectrum sensing implementation.Our proposed model outperforms by providing less sensing time with higher throughput and reduces the complexity also by with standing best among the all methods in the present trade environment.

II. LITERATURE SURVEY

Mohamed Grissa et.al [4] proposed model ensures the protection to the sensed spectrum location. This paper outputs privacy control protocol with the use of cryptography to preserve the location of secondary users while performing spectrum sensing more reliably and efficiently. This paper attempted to achieve fault tolerance and robustness method against the topological changes of the network.

Saud Althunibat et.al [5] addressed spectrum sensing drawbacks and solutions. Energy consumption is one of the biggest challenges of CRN’s that limits the battery power of the terminals. Spectrum sensing requires more energy and puts impact on the data transmission.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

ReenaRatheeJaglan et.al [6] Conducted comparative study on single user in spectrum. A brief survey is carried out of all the major contributions in the field of single user or non-cooperative spectrum sensing for cognitive radio networks. A comparative study is done with important parameters under considerations for real time implementation of CRN.

Deepika Jain et.al [7] proposed dynamic threshold energy detection approach for CR spectrum sensing. Dynamic thresholds are computed based on the current state of primary users by considering the effects of uncertainty of noise. From result section it is proved that, this approach is 3.5 times better than the other energy detection scheme.

Yuan Ma et.al [8] proposed a method that includes multi coset sampling based wideband spectrum sensing scheme for both individual and cooperative sensing environments. The advantages of this scheme are minimum energy consumption on wideband signal acquisition, processing, and transmission, with guaranteed detection. Wideband scheme blindly allocates spectrum without having previous knowledge.

Moslem Rashidi et.al [9] proposed a technique that makes use of multi coset sampling. Coset samples are used toconstruct the correlation matrix of input signal. The results shown in this paper depicts that, even in low SNR with taking enough number of samples a perfect detection can be accomplished effectively.

ShwetankMistry et.al [10] developed a simple COR algorithm for spectrum sensing. But COR is suboptional hencenot used for data recovery. COR algorithm is very simple to use and assures a best choice when operating at low SNR for detection.

ArunKumarJayaprakasam et.al [11] developed DualCUSUM algorithm which is based on sequential change detection method that requires previous knowledge. But DualCUSUM also needs spectrum gains knowledge assigned for each secondary user. For this purpose a modified DualCUSUM called GLR-CUSUM is presented.

KamelBerbra et.al [12] proposed an efficient spectrum sensing method for detecting unsynchronized OFDM signals in additive white Gaussian noise (AWGN). This method is less complex compared to other algorithms. Detectors preferred hereare an energy detector (ED), sliding window detector (SW) and Axell's detector to guarantee a low sensing time.

III. METHODOLOGY

Figure 1, illustrates the proposed method for sensing spectrum in cognitive radio system using Particle Swarm Optimization (PSO). The method follows the following steps. Primary users are to be assigned with a spectrum to use. Allocated spectrum has to be utilized completely by the primary users. If not then unused spectrum will be left as it is. Hence when primary user is not using the spectrum, it has to be sensed and unused spectrum can be allocated to the secondary users.

For the proposed method, 5 carrier signals as primary users are created. All the primary users are assigned with a time slot to restrict the use of spectrum completely for a long time. Allocated spectrum is to be modulated for further processes. The underutilized spectrum has to be sensed by the use of some algorithms. Particle Swarm Optimization technique is used for this purpose only, which examines the availability of the free spectrum. A normal threshold value is set to check the underutilization of the spectrum by the primary users. If the energy level of the spectrum is greater than the threshold value, then it is understood that primary user is not using the spectrum entirely, that is it can be allocated to secondary users. Here it is necessary to create priorities for secondary users also if numbers of secondary users are more who is requesting for the spectrum. Instead of allocating the free spectrum to secondary user randomly, priority list will be followed to allocate the spectrum in order to accomplish the fairness in spectrum allocation. If the energy of the spectrum is less than the threshold decided then, the timer assigned to the primary user is checked. If timer out condition occurs then PU is blocked for time‘t’. For this time ‘t’ secondary user is allocated to use that spectrum until the request from PU is made.

At the end time taken for sensing the spectrum, attenuation and PSNR parameters are considered and conclusion is given that attenuation and PSNR has an impact on the system that will deteriorate the signals. PSO plays a better role in sensing spectrum with better time.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

3.1 Particle Swarm Optimization (PSO)

In order to understand the working of PSO technique, the following bird flocking scenario is supposed where a collection of birds, which are randomly probing for food in a surrounding area. All the birds are not having the idea that where the food is. Through each repetitions, birds gain the knowledge based on their inter communications, where and how far the food is. The only logic preferred here, is to track the bird or follow the bird which is closest to the food.

To resolve the spectrum sensing scenario this PSO technique works better. Each single result in PSO is a bird in search area and it is called as a particle. Each particle have fitness standards which are premeditated by the fitness function i.e. the cost function should be optimized, and have velocities which is used to short the path of flying particles.

For every iteration two "best" values are acknowledged by each particle. Foremost is considered as position vector of the finest solution (fitness). The fitness assessment is also stored and this position is called 'pbest'. An additional best position that is tracked by the particle swarm optimizer is the best position, obtained by any constituent part so far in the bird population. This best position is the currentglobal best and is called 'gbest'. Upon finding these two best values, next step is to calculate or change the velocity and position of the particle. Finally calculate the fitness of that particle. The following equations (1) and (2) are used to find the velocity and position change of the particle.

$$vi,d(t+1) = w(t)vi,d(t) + \emptyset prp(t)\big(pbesti,dxi,d(t)\big) + \emptyset grg(t)\big(gbestd - xi,d(t)\big) \quad (1)$$

$$xi,d(t+1) = xi,d(t) + vi,d(t) \quad (2)$$

IV. IMPLEMENTATION

The overall steps followed in spectrum sensing using Particle Swarm Optimization is shown in Figure 2. First the spectrum initialization is performed with parameters like sampling frequency, time vectors, bandwidth, length of the channel, and calculate the number of active channels to allocate bands for use.

The spectrum generation starts with identifying the number of active channels. Select one sample pattern using sequential forward search scheme. Generate the input signal with some characteristics and let that signal as x(t). Generated input signal will be in time domain, convert that to frequency domain using FFT hence the signal will become as X(f).

Then multi-coset sampling is performed on the signal. To remove noisy contents FIR filters are applied. The Eigen values and Eigen vectors are calculated which helps us to check whether the spectrum energy level have gone low. Using Minimum Description Length function is used to set the threshold for sensing the spectrum which is underutilized. To calculate number of active channels the arithmetic and geometric means of computed Eigen values are evaluated.

Once the numbers of active slots are found the next step is to find their location and find the minimum norm of that to find spectral support then plot an energy graph. Finally Probability of detection and probability of false alarms with respect to SNR is calculated and represented in the form of plot.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

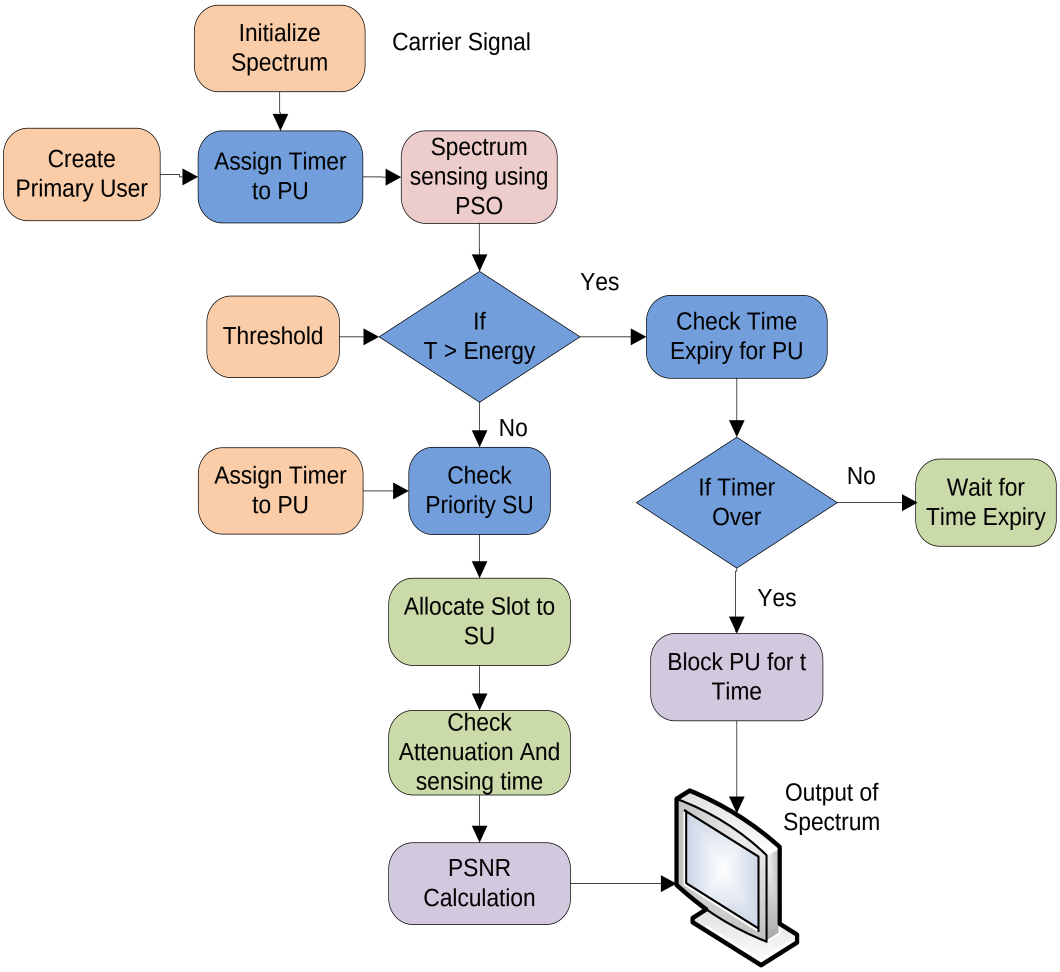

Fig. 1. Architectural Block Diagram

V. EXPERIMENTAL RESULTS

5.1 Spectrum Initialization

For the generation of spectrum only some parameter needs to be initialized. Such as Sampling Frequency (Fs), Sampling Time (Ts), Total Bandwidth allocated (B), Total length of the signal (LL). Based on these parameters initialized, the input signal characteristics are defined.

5.2 Spectrum Generation

Initially there are five primary users using the spectrum with some allocated band limit. The following Figure 3 depicts the initial spectrum for the specified five PU's.

In the following Figure 4, the primary user 4 is not utilizing the spectrum. That is been sensed by the use of PSO technique. So now it can be allocated to secondary users for the betterment of efficient spectrum allocation to improve the efficiency of spectrum as well as throughput.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

The following Figures 5 and 6 represents the false alarms generated and detection rates with respect signal to noise ratios. It concludes that as signal to noise increases the number of false alarms decreases and as the signal to noise increases detection ratio also increases. Lesser the distortion higher will be the probability of detection and lower probability of false alarm rates.

The following comparison table indicates the effectiveness of PSO over another algorithm called genetic algorithm (GA) in the optimization of CR [13]. Based on the specified parameters PSO presented in our paper proved best compared to GA. For the details refer Table 1.

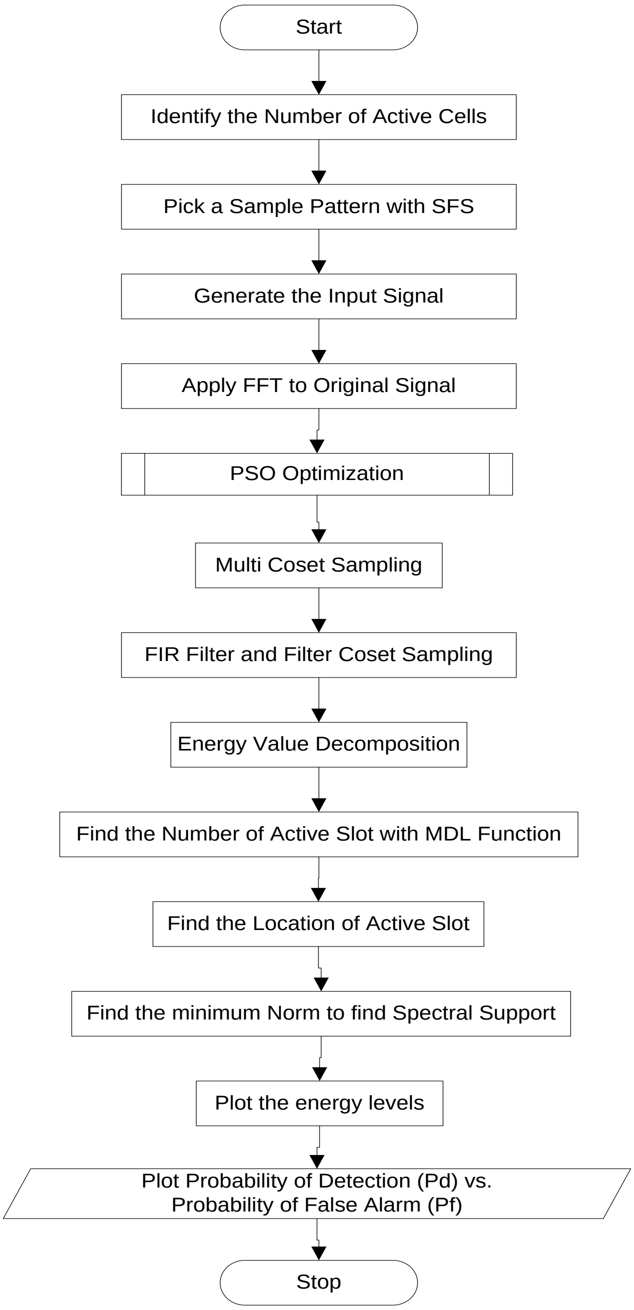

Figure 2: Flow Chart of Spectrum Generation

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

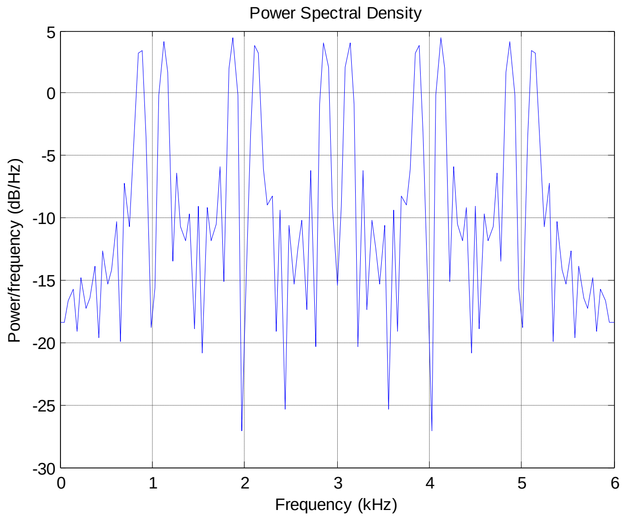

Figure 3: Initial Spectrum with PU=5

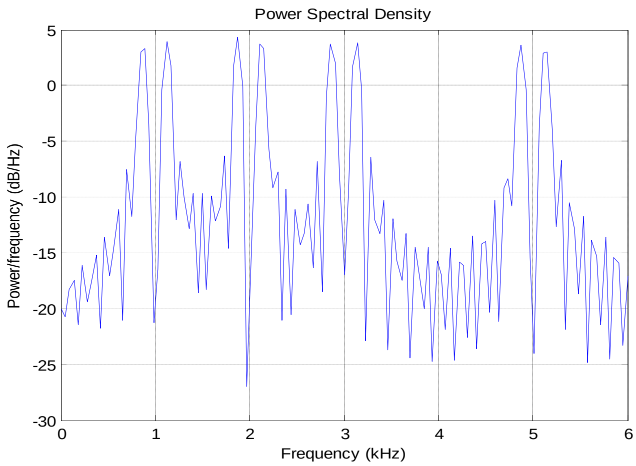

Figure 4: Underutilized Spectrum of Primary users (4) using PSO

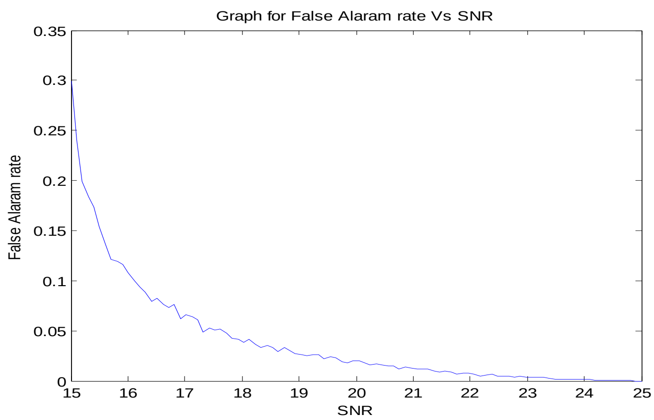

Figure 5: Plot of False Alarm Rate Vs SNR

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

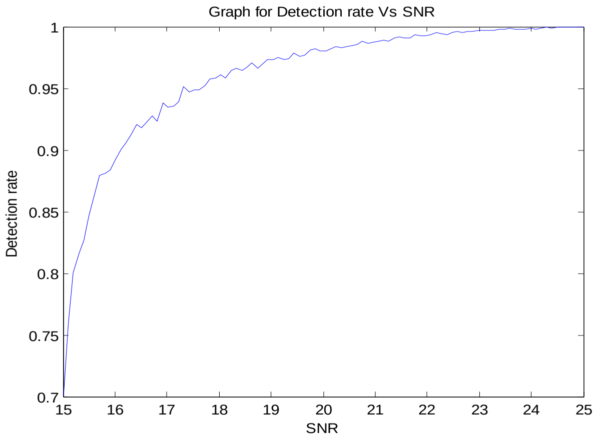

Figure 6: Plot of Detection Rate Vs SNR

Table 1: Comparison of GA Vs PSO

Parameters	GA	PSO
Control parameters	Generation rate, crossover rate, mutation rate	Cognitive, social factors, inertia weight
Convergence Rate	Less	More than GA
Complexity	More	Less than GA
Convergence Speed	Less in Large space	Better than GA
Flexibility	Flexible	More than GA
Computational Time	More	Less than GA

VI.CONCLUSION

Our proposed Cognitive radio spectrum proves better results compared to other spectrum sensing algorithms. The use of PSO eases the complexity, increases the convergence rate, increases flexibility, Increases the convergence speed and minimizes the computational time as shown in Table 1.

PSO is considered as the best algorithm or optimized algorithm for sensing the spectrum in less sensing time with more detection rate and less false alarm rates as depicted in result section. Lesser the distortion more will be the probability of detection and lesser will be the false alarm rates. As it is known that spectrum allocation with quality of service is a big issue in Cognitive radio spectrum. PSO is one among them which is easy, less complex and performs sensing with less time to increase the efficiency of detection by resulting in to highest throughput.

The use of multi coset sampling enhanced the reduction computational time because it uses low sampling rate close to the channel occupancy. The resultant plots of detection rate Vs SNR and false alarm rate Vs SNR depicts the probability of detection with increase in SNR almost reached 100% and false alarm rate almost reached 0%. From this we can conclude that it can give the efficiency more compared to wide band spectrum sensing techniques [9].

REFERENCES

[1] Yuan Ma, Yue Gao, Ying-Chang Liang, and Shuguang Cui," Reliable and Efficient Sub-Nyquist Wideband Spectrum Sensing in Cooperative Cognitive Radio Networks", IEEE ,Volume 34, Issue 10, Year 2016.
[2] Dhanshri D. Kulkarni, Prof. Vineeta P. Gejji, "Energy Detection Using Haar Wavelet in Cognitive Radios Systems", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Volume 5, Issue 6, Year 2016.
[3] Dakshata Patel, Prof. Vineeta P. Gejji, "Energy Detection Using Discrete Wavelet Transform in Cognitive Radio System", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Volume 5, Issue 6, Year 2016.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

[4] Mohamed Grissa, Attila Yavuz and Bechir Hamdaoui, "An Efficient Technique for Protecting Location Privacy of Cooperative Spectrum Sensing Users", IEEE, Year 2016.
[5] Saud Althunibat , Marco Di Renzo, Fabrizio Granelli, "Towards Energy-Efficient Cooperative Spectrum Sensing for Cognitive Radio Networks An Overview," Springer, Year 2015.
[6] Reena Rathee Jaglan, Sandeep Sarowa, Rashid Mustafa, Sunil Agrawal, Naresh Kumar," Comparative Study of Single-user Spectrum Sensing Techniques in Cognitive Radio Networks", Elsevier, Year 2015.
[7] Deepika Jain, Amanpreet Kaur, Swaran Ahuja," Enhanced Cognitive Radio Energy Detection Technique based on estimation of Noise Uncertainty", International Journal of Advanced Research in Computer Engineering & Technology, Volume 5, Issue 5, Year 2016.
[8] Yuan Ma, Yue Gao, Ying-Chang Liang, and Shuguang Cui," Reliable and Efficient Sub-Nyquist Wideband Spectrum Sensing in Cooperative Cognitive Radio Networks", IEEE ,Volume 34, Issue 10, Year 2016.
[9] Moslem Rashidi, Kasra Haghighi, Arash Owrang, Mats Viberg, "A Wideband Spectrum Sensing Method for Cognitive Radio Using Sub-Nyquist Sampling", IEEE, Year 2011.
[10] Shwetank Mistry and Vinod Sharma, "New Algorithms for Wideband Spectrum Sensing Via Compressive Sensing", IEEE, Year 2013.
[11] ArunKumar Jayaprakasam and Vinod Sharma, "Sequential Detection based Cooperative Spectrum Sensing Algorithms in Cognitive Radio",IEEE, Year 2009.
[12] Kamel Berbra, Mourad Barkat, Fulvio Gini, Maria Greco, Pietro Stinco, "A fast spectrum sensing for CP-OFDM cognitive radio based on adaptive thresholding", Elsevier, Year 2016.
[13] Payal Mishra, Mrs. Neelam Dewangan, "Survey on Optimization Methods For Spectrum Sensing in Cognitive Radio Network", International Journal of New Technology and Research, Volume 1, Issue 6, Year 2015.