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ADAPTIVE DOUBLE THRESHOLD ENERGY TECHNIQUE OF SPECTRUM SENSING TECHNIQUES FOR WIRELESS COGNITIVE RADIO NETWORKS

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Abstract

Wireless communication should mainly tackle the issue if spectrum under utilization, it is overcome by this cognitive radio method. Sensing of spectrum is the very essential and foremost aspect in cognitive radio. There are various algorithms are available in sensing the spectrum due of the easy implementation of the energy detection method is used widely, as it will not consider any prior information about primary user (PU). In low Signal Noise Ratio portion, the energy detectors will progressively worse its performance. In order of reaching increased reliability of the decision the Cooperative Spectrum Sensing with dual threshold is presented.

Keywords: *cognitive radio, spectrum sensing, energy detection, primary users, secondary users.*

COGNITIVE RADIO-OVERVIEW

Cognitive Radio (CR) system is the technique for wireless networks which overcomes the problems which are faced in the spectrum utilization. The PU is the user who owned the spectrum via appropriate license and the SU is the user who doesnot own the spectrum and they will not be provided with the appropriate license. In CR technique, the secondary user looks for unused licensed band that are distributed to primary user. Nowadays the flexibility of the wireless communication has become very essential considering the growth in wireless network and also by the use of internet technologies in collaboration with mobile systems. The most essential resource in customer service is spectrum .According to the insufficient resource of spectrum, the efficient spectrum utilization is the very essential aspect. This effective way of utilizing the spectrum was attained by the CR Technology. The growing demand of applications in wireless networks have improved the technology and radio spectrum usage.

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ARCHITECTURE OF COGNITIVE RADIO

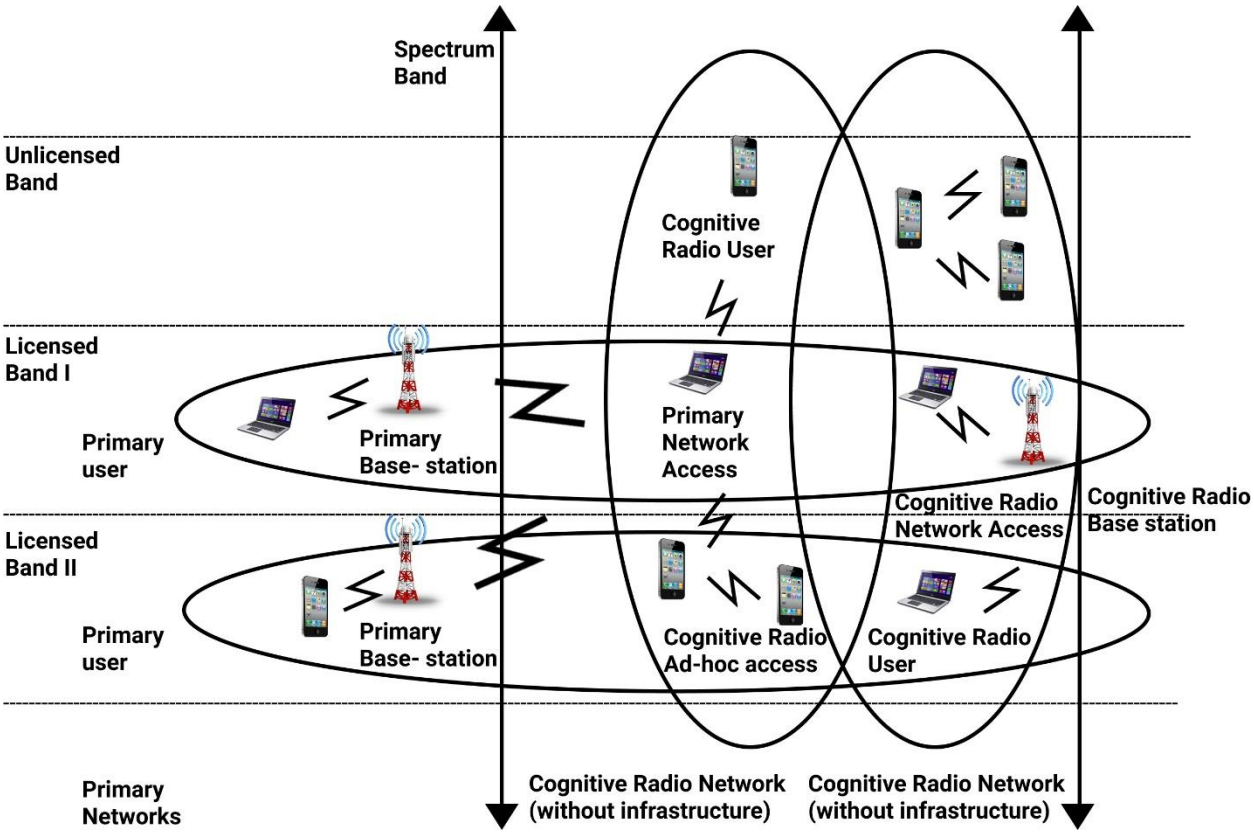

figure 1: Cognitive radio architecture

COMPONENTS OF COGNITIVE RADIO NETWORK

The architecture of Cognitive Radio network can be grouped into two categories: they are, existing network and the Cognitive Radio network. The primary network is mentioned as an existing network, here PU's will own the spectrum [12]. The activities of primary user are taken under the control of primary base stations. Because of the greater priority, the PU's operations must not be troubled by the unlicensed users. License will not be provided to the CR network users to establish its function in a band as it desires. Once the free spectrum is detected, then a Single-hop connection will be provided to the base stations of the Cognitive Radio Network users. Each CR network will have separate spectrum broker, spectrum brokers will be having a major part in spreading the spectrum.

COGNITIVE RADIO TYPES

There are 2 groups of Cognitive Radios:

- Completely packed Cognitive Radio
- Semi Packed Cognitive Radio

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COGNITIVE RADIO FUNCTIONS

The four main functions of cognitive radio networks are

1) Sensing the radio environment
2) Managing the spectrum
3) Spectrum sensing
4) Allocation of spectrum
    - In completely packed cognitive radio all the four functions will be carried out in the cognitive radio network.
    - In semi packed cognitive radio,only the sensing process will be carried out and will be intimated to spectrum brokers for further process.

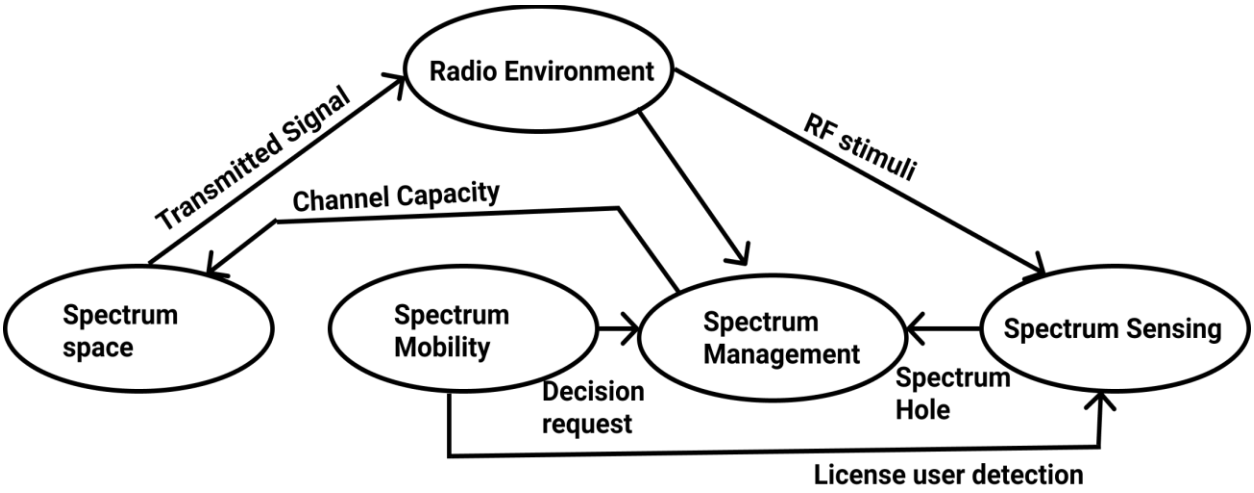

Figure 2: Basic cycle of cognitive radio

- There different methodologies of sensing the spectrum management are given in Figure 1.3[1]. Each sensing methods has own advantage and disadvantages.

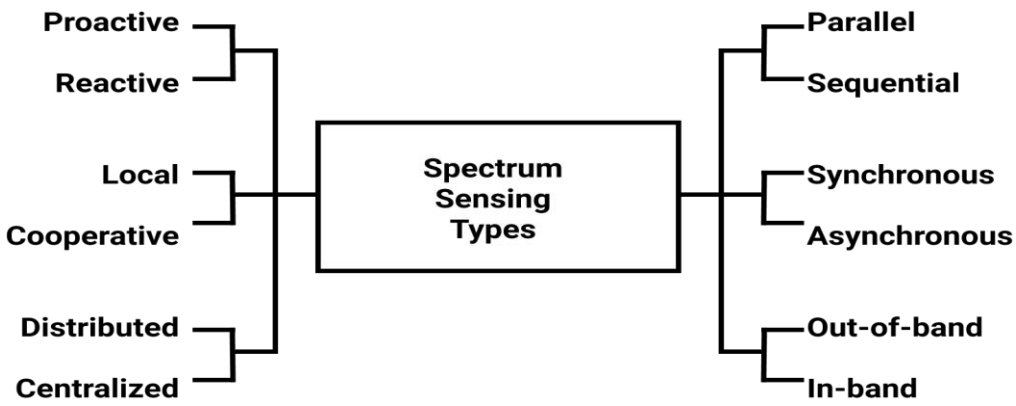

Figure 3: Spectrum sensing management methods

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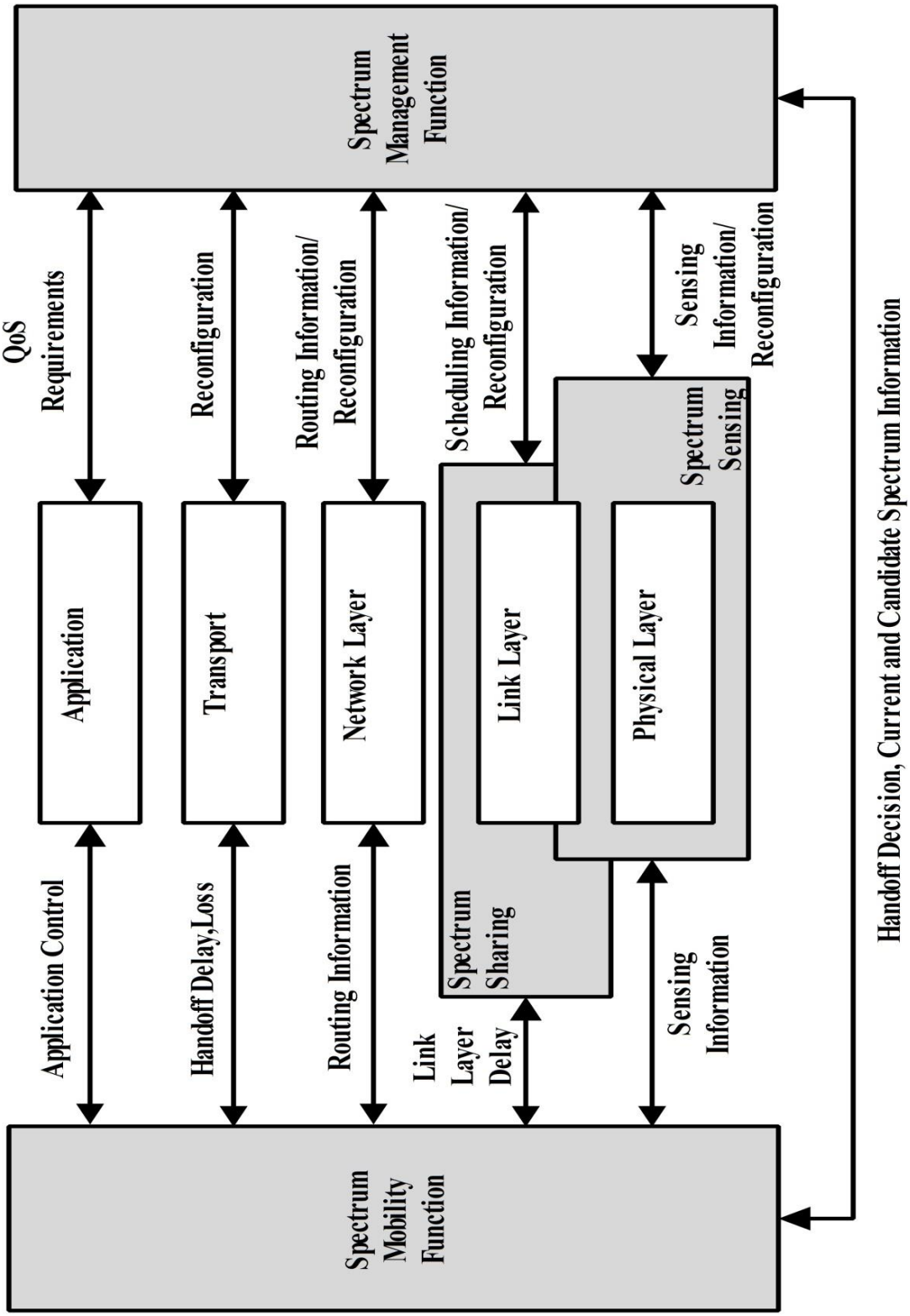

Figure 4: management agenda for spectrum in CRNs.

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CHALLENGES OF SPECTRUMSENSING

The sensing process becomes challenging by various factors like ability to differentiate modulated signals, interference and Signal to noise ratio. At lower SNR conditions the detection process will be difficult. The occurrence of multipath fading is when signals reaches a receiver by multiple paths and their comparative strengths and change in phases and the power associated with the signal becomes weak then there will be complication for the secondary user in detection of PU existence. The level of interference along with noise will be modified based on time. This modification will lead to the complication in sensing the spectrum. Most common problems are as follows:

A. Security
B. Hidden Primary User Problem
C. Sensing duration and frequency
D. Uncertainty in Channels
E. Noise Uncertainty
F. Aggregate-Interference Uncertainty

COGNITIVE RADIOS APPLICATIONS

The applications are as follows:

- Leased network
- Mesh cognitive network
- Emergency network.
- Military
- Applications in public security
- Surveillance Applications

PROBLEM DESCRIPTION

Based on the licensed user of the spectrum only the cognitive radio networks performance will vary. The sensing is the vital and preliminary function of CRN, it should have the ability to detect the weak primary user signals. The sensing function depends on noise interference level of PU, so noise interference level should be kept minimum. By increasing the SNR value of all the primary users, the minimal noise interference level can be achieved .This minimization of the noise interference value will help in effective sensing process.

EXISTING METHODOLOGY

Sensing is the function that it detects the unutilized spectrum and shares the information with other users without any interference which are harmful. One of the basic issues was to sense environment accurately and to declare whether the spectrum is idle or being used. The non-interference of the PU was

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guaranteed, CR must have the capacity to detect the weak signals. In degraded wireless channel the sensing operation becomes very difficult due to random fading.

In spectrum sensing operation the energy is detected and on the basis of unused frequency in the channel the SU are allotted. The non-coherent detection detects the availability and non-availability of band. Since, the improper utilization of frequency of the spectrum is eliminated by allowing the SU to utilize the particular band in the PU when it is unused by the primary user. This allows the complete utilization or fully occupied bandwidth. The sensing detection never considers prior information, state of the channel, and prospective of the PU's signal.

PROPOSED METHODOLOGY

DOUBLE THRESHOLD ENERGY DETECTION

In cognitive radio, the conventional energy detector will make decisions on their own depending on only one threshold value. In proposed method decision is made by comparing between the two threshold levels. Let λ represents the threshold energy level, λ_1 denotes the lesser threshold level and λ_2 denotes the greater threshold level. The sensed energy after calculation of a PU is presented as Y.

Let h(t) be the signal energy detected, w(t) be the noise samples and it is observed in the time R.

P_0: S(t)=w(t)----------(1)

P_1: S(t)=h(t)+w(t) ---------(2)

t=1,…,R; where R is observation interval

If P_0 exist means, then the PU transmission is absent and P_1 exist means then, PU is transmission is present.

In Double threshold energy detection method probability P1 is true if Y is more than λ_1 and is less than λ_2. By using double threshold method fault detection due to noise is minimized[7].

Detection of energy method for sensing the spectrum is the simplest detection method. The energy level associated with the PUis calculated by means of the energy detector during the observation interval.When the energy value then it will be declared as spectrum hole. Flow chart of the Energy Detector executionis given in Figure.

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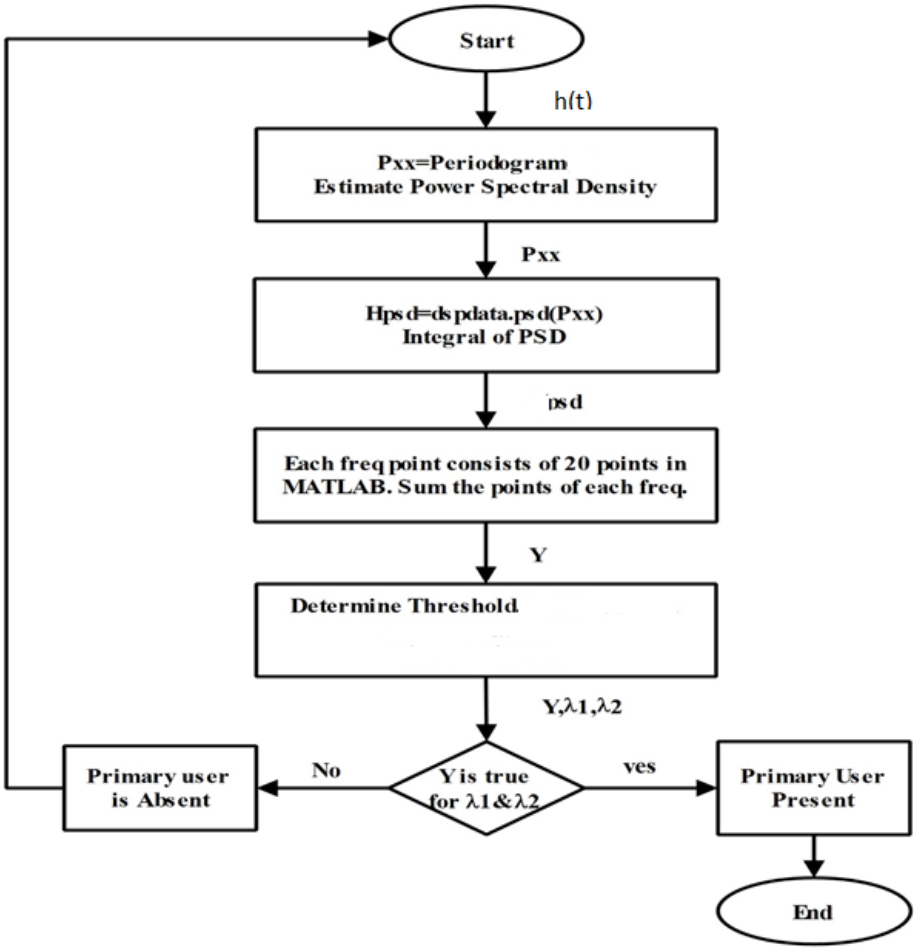

FIGURE 5: ENERGY DETECTOR IMPLEMENTATION

STEPS INVOLVED IN FLOW CHART

Step 1: Estimation of power spectral density is carried

Step 2: The estimated power spectral density is integrated over a frequency and finds the average of power associated with the band

Step 3: 20 points in the MATLAB corresponds to a single frequency.

Step 4: In carrying out an experiment when low and high results are obtained then it will be compared with λ1 and λ2 .

Step 5: Then the integrator output will be compared with λ1 and λ2 (threshold values)to find the presence of primary user.

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ALGORITHM OF ENERGY DETECTION USING ADAPTIVE DOUBLE THRESHOLD VALUE:

1: Input: $\{\lambda_1,\lambda_2\}$
2: Output: D_i
3. Activationof ED
4: for every single Primary User
5: Sensing Y→ Observed Value
6: $\lambda_1 \geq Y \leq \lambda_2$
$D_i = H1;$
7: else
$D_i = H0;$
8: end for
9:End of algorithum

RESULTS AND DISCUSSION

For simulation, we have used mat lab software i.e. MATLAB 2014A. Monte-Carlo simulations were carried out where 1000 samples and fixed Pf at 0.01 is taken for analysis. The power spectral density of the received signal helps to determine the existence of PU. It detects power which is associated with the spectrum. Certain frequencies will have appropriate amount of energy.

Graph of power spectral density

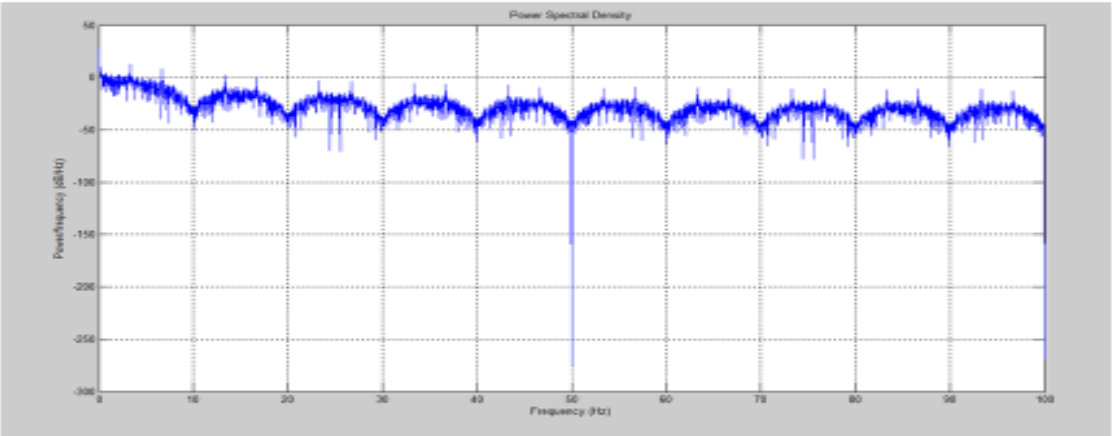

Figure 6: POWER SPECTRAL DENSITY

In this method of the primary user detection, the users which satisfies the threshold energy values are detected. The graph illustrates the primary users which are detected.

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The Figure 7 represents the detected primary users. The points falling between 0.75 to 0.9along the probability of detection (y-axis) represents the presence of the primary user in the spectrum.The points falling along the 0 and 1 in y-axis denotes the lack of PU in the spectrum. Since the existence of the PU is detected the secondary user will not be allowed to use the spectrum.

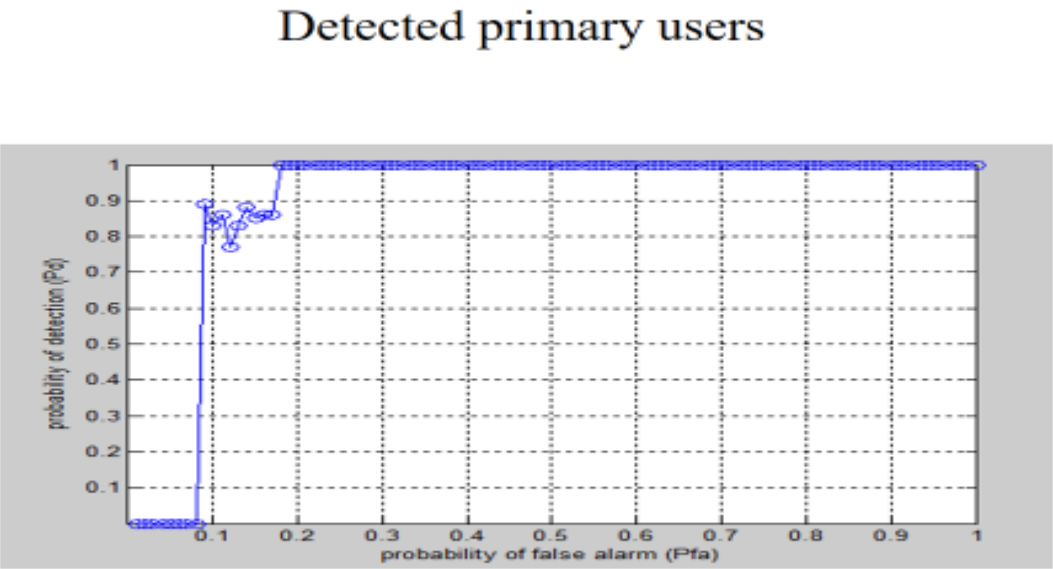

Figure 7:Detected Primary Users

In this method of the primary user detection, the users which satisfies the threshold energy values are detected. The graph illustrates the primary users which are not detected. These primary users which are not detected will not be equal to the threshold energy value. Figure8 represents the primary users which are not detected. The points falling along the 0 and 1 in y-axis denotes the absence of PU in spectrum. Since the primary user absence is detected the spectrum can be utilized by the SU.

The points falling along in-between 0.1-0.3 represents the presence of the primary user in the spectrum.

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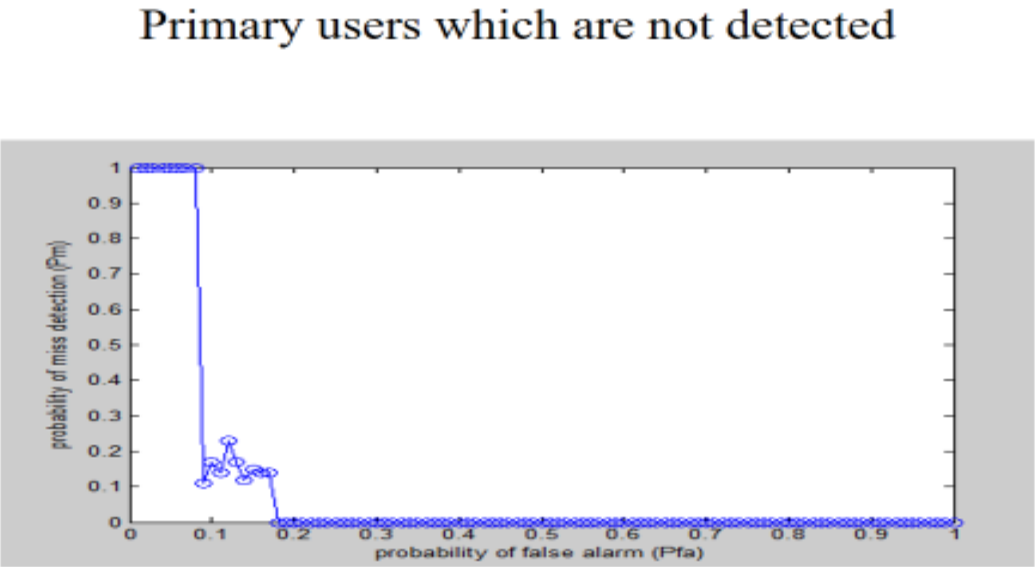

Figure8: primary users which are not detected.

FUTURE ENHANCEMENT

In energy detection method, no information of the PU signals is needed. Therefore it would be easy to implement, this is the important reason to be the mostly utilised method. When the power associated with the signal is low and also as it is sensitive to noise and it will not be capable to distinguish between signal and noise. The energy detectors sensing threshold is an important parameter. When a detector fails to be adjustable threshold properly, it undergoes from some degradation in the spectrum sensingperformance. Hence better algorithms are needed to be implemented. So that sensing of spectrum is going to be designed with matched filters in future works.

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