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ANALYSIS OF ENERGY EFFICIENCY USING IED WITH SELECTION COMBINING IN PROPOSED CSS NETWORK OVER WEIBULL CHANNEL

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Abstract— **In the Present Scenario, a message can be transmitted to the user, if the signal in which it contains must be efficient and accurate. There are many parameters like noise signals and unknown signals etc, which shows great impact on signal efficiency and its range. The removal of unknown signals is the primary objective in order to prevent loss of information from the signal. Unknown signals which causes disturbances in effective signal transmission are detected and its energy efficiency is compared before and after removal of unknown signals. This Research Paper mainly uses a Improved Energy Detector which consists of Cognitive nodes which helps the identification of unknown signals by applying various variations (i.e fading environment). Each nodes are subjected with some number of antennas. Probability functions are used to detect the false probability alarm signals which causes interrupts in the signal. Analysis of overall channel is done throughout the process of detecting and removing of unknown signals.**

Keywords— **Cognitive Radio Nodes, Energy Efficiency and Improved Energy Detector.**

I. INTRODUCTION

Typically, signal transmission from transmitter to receiver plays a significant role in communication. The channel is traversed by signals, which transmit binary information. There are many different kinds of signals, but radio frequency signals play a big part in communication. The radio spectrum is where we get radio frequency signals. The radio frequency spectrum [1] is a resource that can be found anywhere in the world. It operates at a wide frequency range, from 30 Hz to 300 GHz. Each RF signal can be used for only one purpose at a time, and each frequency range has its own specific applications.

The efficiency of the radio frequency spectrum gradually decreases when a RF signal is only utilized for a single purpose. It results in improper frequency band utilization. The primary objective is to locate the vacancy bands and unknown signals. By using the method known as cognitive radio [4] this can be performed in efficient manner. Cognitive radio is made up of cognitive users who recognizes the absence of primary users, find vacant bands and making them to use . In this research paper, the primary user represents the unknown signal. The crucial key terms for cognitive radio technology [4] which is a part of wireless communication are primary user and secondary user. The primary user transmits, while the secondary user receives the transmitted signal. Cognitive radio leads to innovation of technology by detecting probability of vacancy band which is also low.

For cognitive radio technology, there are various energy detection methods, which includes conventional and improved energy detection methods [3] . When it comes to finding the right information about vacancy bands, we typically favour to use improved energy detection methods. On comparing to other methods, it has a high detection probability. comparing it to other methods, The primary objective is to locate and make use of the radio spectrum's unused frequency bands in order to improve radio frequency spectrum efficiency [2]. The term "average channel throughput" [11] is used to describe the maximum amount of energy required to transmit data between two points. In today's world of communication, wireless communications has a significant impact. It is huge and depends on many different things. Changes in these parameters indicate significant shifts in message transmission between points.

II. OVERVIEW AND BACKGROUND

A. Spectrum Sensing Network

It is described as the process of routinely scanning the RF spectrum to identify any open bands that may be present [5] .It serves a crucial purpose for cognitive radio technology. Its main job is to safeguard the network from unwanted interference from primary users and to locate empty frequency slots so that spectrum usage can be improved.

B. Improved Energy Detector

Energy detectors are typically essential for spotting random signals among noise in energy detection [1]. These energy detectors operate under the premise of comparing the assumed noise power to the threshold power. To determine if the vacancy band is present in the primary user or not, an energy comparison detector [6] is used. Improved Energy Detector differs from standard methods in that it transmits the received signal's arbitrary power to the receiver rather than its square. As a result, cognitive radio's performance will be improved.

C. Cognitive Radio and Fading Channel

Cognitive Radio is a type of radio which is used in wireless communications in order to avoid creation of interference. It automatically detects the available vacant bands in the spectrum, and helps to allow the change in parameters of communication which increases efficiency.

Fading is the process of attenuating a radio frequency signal (increasing/decreasing amplitude). A channel type which is used to utilize for increasing the signal strength is called as fading channel [8]. Signals travelling in several paths from one location to another as a result of CR nodes creates fading. Typically, we refer to fading in a communication channel when reflectors are present. Various random variables are used to categorising the fading affect. Weibull distribution is necessary for Weibull fading [9]. It is mostly influenced by the factors shape (k) and scale(lambda).

III. PROPOSED ALGORITHM

A. Existing methodology–

The papers current methodology focuses on traditional energy detecting techniques. This technique is used in a single spectrum sensing network. T here is only one CR in this network for spectrum sensing (i.e Cognitive radio). One can track the status of the Primary User and find the vacant bands with the help of CR users. It keeps the information about unused frequency bands and records it in binary form. Primary signal has access to all kind of frequencies in RF spectrum, Because of this, a single CR node has a low detection probability, which makes it difficult to detect users across the entire spectrum of radio frequencies. we can observe in the change in Average Channel throughput and further decrease in efficiency and energy of signal.

B. Proposed Methodology

A network of cooperative spectrum sensors makes up the proposed system. As discussed earlier, the cognitive radio nodes that make up the cooperative spectrum sensing network is an improved energy method. It consists of one primary user, one secondary user, and N no. of cognitive radio nodes (CR). There are M number of antennas in each CR node. The cooperative spectrum sensing network has two channels: a sensing channel and a reporting channel. One is used to collect data from the primary user, while the other is used to transmit this data to the secondary user (i.e Fusion center).

For periodically checking the state of the primary user and to save the relevant information, multiple CR nodes are implemented. It stores the information in binary format in the M number of antennas. This cooperative spectrum sensing network [10] is being tested in a fading channel. Because M number of antennas have M number of bits of information on the final status of Primary user to locate unoccupied bands, they utilize selection diversity technique to fix the best value to the complete CR node. Due to the fading effect in wireless transmission C_{avg} value decreases

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.This may lead to the fall in detection probability, so Cavg value should be increased.

The waves that are propagating in multi-path are analyzed using an IED scheme based CSS in Weibull channel, which is also effective for heterogeneous communications. One can quickly model both interior and outdoor communication conditions for such networks using the Weibull distribution. Expressions for the missed detection and false alarm probabilities in closed form are supplied for the proposed system. Performances in weibull fading are evaluated for average channel throughput, energy efficiency, and complementary receiver operating characteristics (CROC).

Every cognitive radio supports the IED protocol [6] and is capable of transferring all binary data. Through the reporting channel, it sends the data to the fusion center. The final decision regarding PU status is made at the fusion center. We employ the AND- Rule and OR- Rule at the fusion center denoted by k=N-n and k=1+n.The following shows the block diagram of proposed methodology.

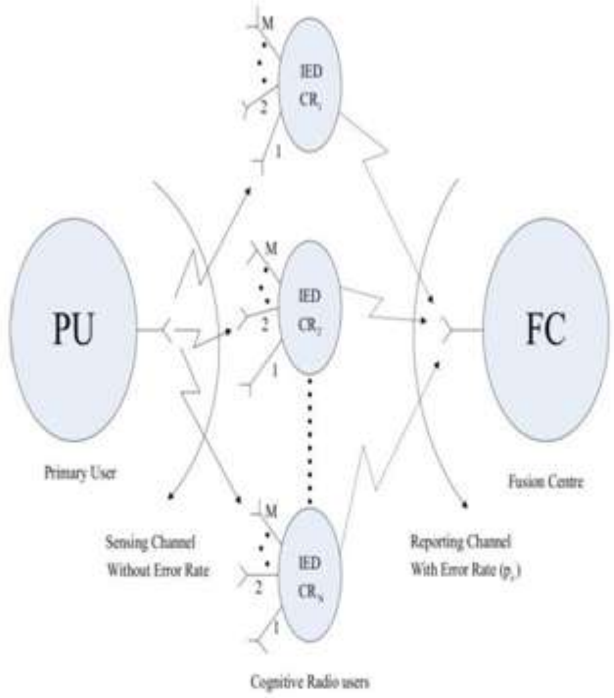

Fig. 1. Block diagram of proposed methodology

IV. CALCULATIONS AND NETWORK PARAMETERS

They are mainly four parameters in order to analyze the entire performance of a cooperative spectrum sensing network which are mentioned below:

1. Missed Detection Probability(P_m)
2. False alarm Probability(P_f)
3. Average Channel Throughput
4. Energy Efficiency

All these expressions can be obtained by finding the equation of the received signal at each CR node in presence of primary user or absence of it. It is representedas

The received signal yj(n) (i = 1, 2, . . . , N)at j- th antenna is denoted as; yj(n)= { wj(n) H0;
hj s(n) + wj (n) H1; } **-(1)**

Where H0 = absence of primary user,H1 = presence of primary user,

S(n) = primary signal,

wj (n) - N (0; 2n) = noise samples and wj (n) and hj are independent at n = index at j = 1, 2, . . . , M antennas, while hj represents the fading channel coefficient, which is dependent on the fading type used in the S-channel. Sequence of Network Parameters which are calculated as by The equation of false alarm is used to determine the error probability percentage which leads to wrong values. It is represented as **Eq (2).**

$P_f = 1 - [1 - \exp(-\{\frac{\lambda^{\frac{2}{p}}\Gamma(p)}{(\sigma_n^2)}\}^C)]^M$ **–(2)**

The missed detection probability equation is used to determine the probability of not detecting the primary user. It is represented as **Eq(3).**

$P_m = [1 - \exp(-\{\frac{\lambda^{\frac{2}{p}}\Gamma(p)}{\sigma_n^2(1+\gamma)}\}^C)]^M$ **–(3)**

Where C= Channel CapacityM= No of Antennas
Γ = Signal to Noise Ratio

In order to calculate Average channel throughput, First it is necessary to calculate Energy Efficiency.

It is obtained by using the probability density functions of both P_m and P_f. They are obtained as Eq (4) and Eq(5).

$$P_{F,K} = \sum_{l=k}^{N} \binom{N}{l} p_{fe}^{l} \left(1 - p_{fe}\right)^{N-l} \quad \text{- (4)}$$

$$P_{D,K} = \sum_{l=k}^{N} \binom{N}{l} p_{de}^{l} (1 - p_{de})^{N-l} \quad \text{-(5)}$$

Usually General Expression for Avg channel Throughput consists of calculating for M no of antennas, It is represented as
Eq(6).

$$C_{avg,k}(N) = \Psi_0 + \Psi_1 P_{D,k}(N) - \Psi_2 P_{F,k}(N)$$
-(6)

where Ψ_0, Ψ_1, Ψ_2 are Weibull fading parameter cofficients.

Average channel throughput
Cavg(N)= η*E(n)

After calculating the final average channel throughput value , Maximum amount of energy obtained can be also calculated from the above equations .

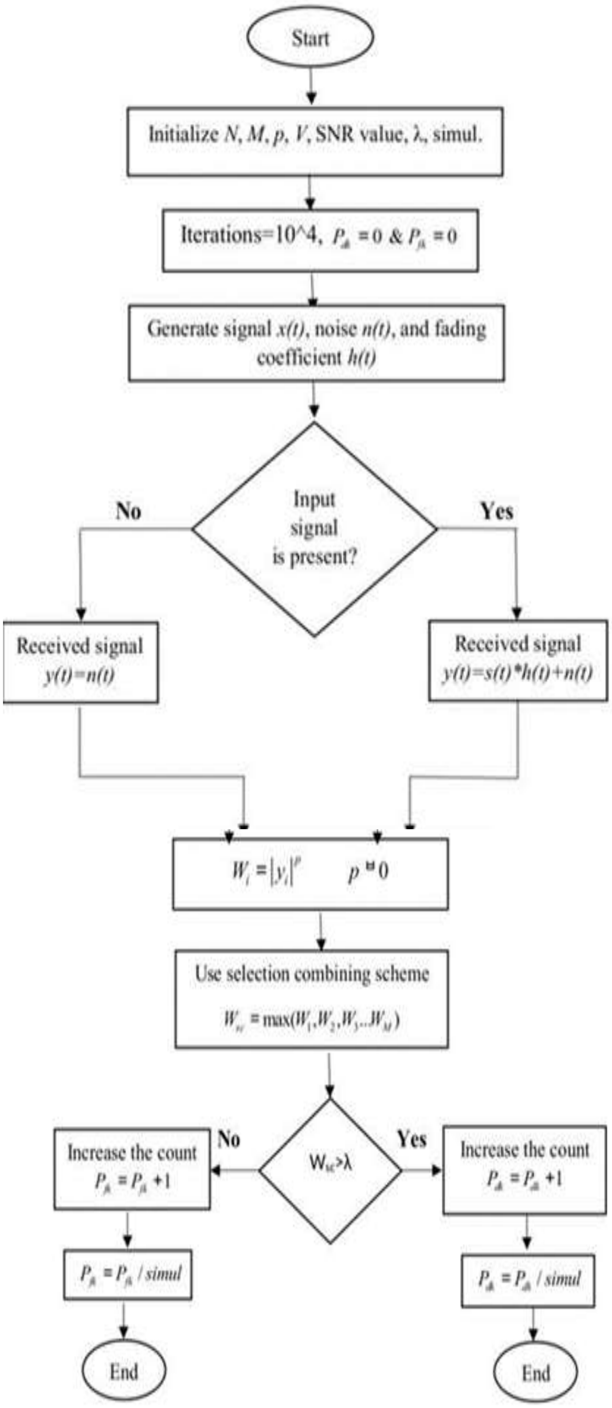

Fig. 2. Flowchart of CSS Network

V. ANALYSIS OF NETWORK PARAMETERS

A relatively new research paradigm, called high throughput (combinatorial) materials is a science methodology which holds the promise of quick and effective materials screening, optimization, and discovery. The most critical two parameters to determine in order to find empty bands are the probabilities of missing detection and false alarm.

On comparing Improved energy detection methods, which use several CR nodes and gradually raise detection probability, to the conventional energy detection methods often use a single Cognitive radio node (CR), which has a low detection probability. By defining a value termed a threshold value, by which performance can be assessed. At each CR node, this pre-defined threshold value is compared to the signal frequency that is received.

These parameters can be further analyzed by finding the interrelationship between the network parameters. These analyzations mainly include the following:

- W (value stored at each CR node) v/s Threshold is compared for various values.
- C_{avg} v/s lambda is compared to obtain maximum energy efficiency.

To find the number of secondary users at fusion center by using fusion rules.

Additionally two more parameters are required called effective false alarm probability and effective detection probability equations which helps use to find the exact percentage of avg channel throughput value.

VI. RESULTS

As a first step of simulating , a graph is drawn between missed detection probability and false alarm probability. It can be assessed by plotting CROC(Complementary Receiver Operating Characteristics) curve. When compared to cases with a large number of antennas, it is obvious that the single antenna case has a high risk of missing detection. The graph below has only been plotted for multiple no of antennas. By observing the below graph we can say that when the P_f value is higher, the Pm value will be lower by that percentage. The likelihood of missing a detection lowers as the number of antennas rises because fading comes into action.

As a second part of the paper, it is essential in order to find how much amount of energy is transmitted from one end to the other after finding the relation between P_f and P_m.

By comparing it to a predetermined threshold value, it is used to determine whether the vacant band is present in the PU or not. We have only calculated the C_{avg} value using the k=1+n rule; further analysis with the other fusion rule is to be performed yet. The error rate is represented in the graph below. There is initially no information going from CR nodes to the fusion center, because C_{avg} value at the reporting channel is to be high. We can observe that there is decrease in C_{avg} value when the fixed threshold value is increased gradually. It depends on error rate value which we apply. Similarly with k=N-n fusion rule as the N value increases C_{avg} value decreases .By raising the error from p_e=0 to p_e=0.2 the C_{avg} value got decreased by 5.7% in case of multiple antennas .By raising the number of antennas from 1 to 2 then the Cavg value will get increased by 16.7%.

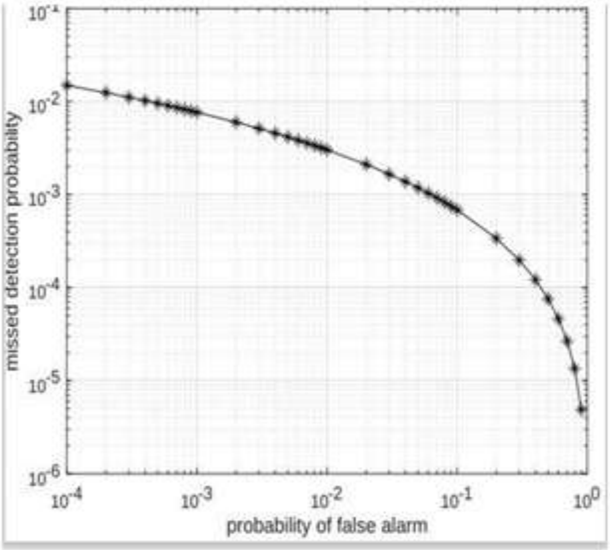

Fig. 3. Complementary ROC analysis in Weibull Fading Channel

The optimal values of SU's decreased by the lambda value When the k value is increased from 1 to 3, the value of M grows from 1 to 4 and from 5 to 14 when M=2 is used at lambda M=4 for both pe =0 and pe =0.2. At higher threshold values, an optimal value becomes constant, indicating that there is no further change in improvement by having more no. of Secondary Users.

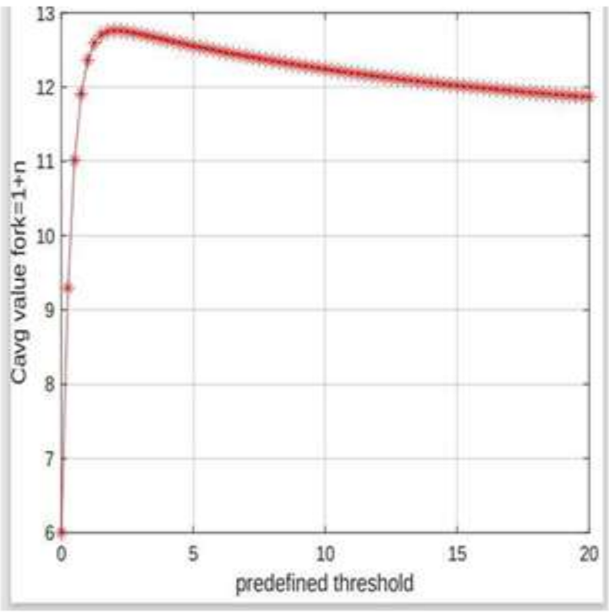

Fig .4. Cavg v/s Lambda using Fusion rule

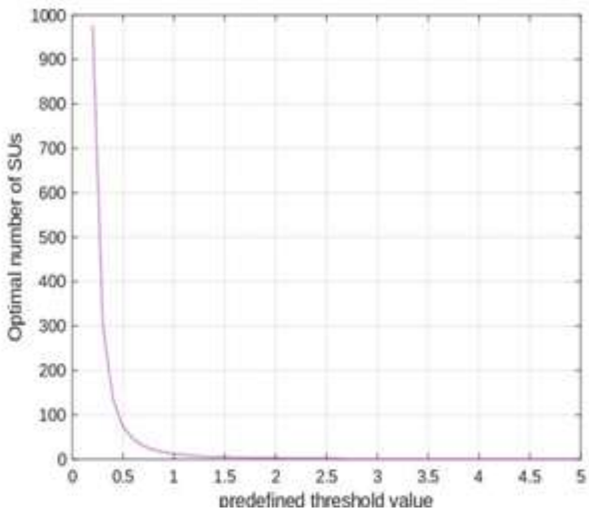

Fig.5. M* lambda with fusion rules

VII. CONCLUSION

In this paper CSS network properties are observed by using IED detector .Each CU is allocated with M number of antennas ,where maximum value of primary user is found by SC diversity scheme by comparing all the Cognitive users false alarm and missed detection probabilities these are identified by MATLAB stimulation . They are calculated by using Weibull fading channel and IED scheme and further stimulation for Cavg, and energy efficiency by fusion rules is observed using CROC curves .The performance in proposed scheme is enhanced than the existing method.

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